

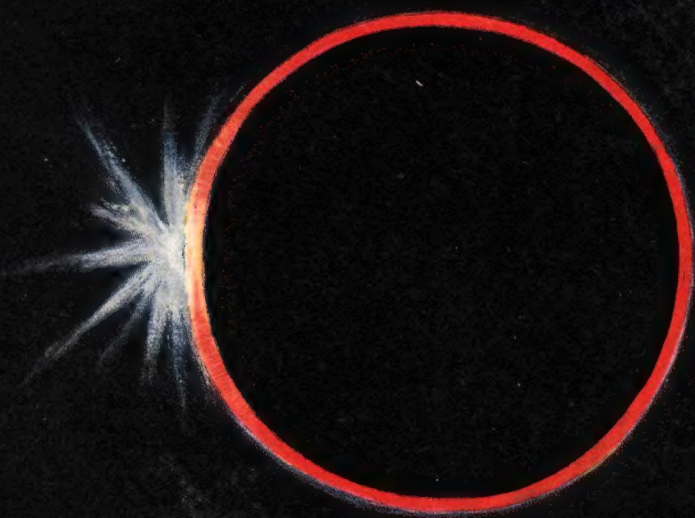
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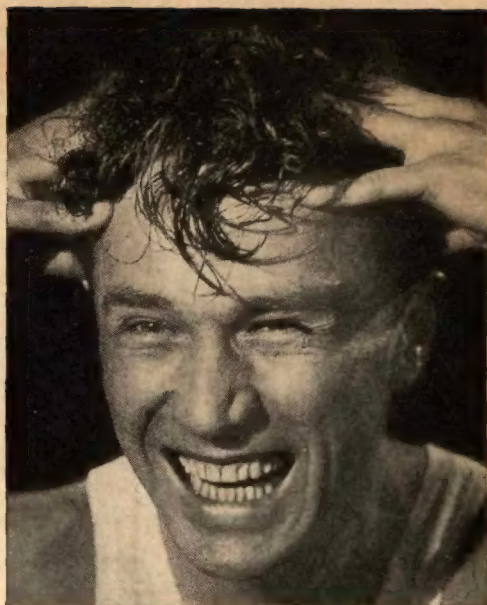
MAR. 1940



URANUS
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THE SUN

"COLD," by Nat Schachner

Good News! for **DANDRUFF SUFFERERS**



Listerine Antiseptic Treatment Fights Infectious Dandruff Clinical Tests Showed Marked Improvement in 76% of Cases

If you are troubled with infectious dandruff, give Listerine Antiseptic a chance to prove how helpful it can be...how quickly it attacks the infection and those humiliating scales...how fresh, clean, and invigorated it makes your scalp feel. Users everywhere acclaim its benefits.

The treatment is as easy as it is delightful. Just douse the scalp, morning and night, with full strength Listerine Antiseptic—the same Listerine Antiseptic that has been famous for 25 years as a mouth wash and gargle. Massage hair and scalp vigorously and persistently. In clinical tests, dandruff sufferers were delighted to find that this treatment brought rapid improvement in most cases.

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Dandruff is the most frequent scaly disease of the scalp. When this condition is due to germs, as is often the case, Listerine is especially fitted to aid you. It gives the scalp and hair a cooling and invigorating antiseptic bath...kills millions of germs associated with infectious dandruff, including *Pityrosporum Ovale*. This strange "bottle bacillus" is recognized by outstanding dandruff specialists as a causative agent of infectious dandruff.

Improvement in 76% of Test Cases

Rabbits inoculated with *Pityrosporum Ovale* developed definite dandruff symptoms which disappeared shortly after being treated with Listerine Antiseptic daily.

And in a dandruff clinic, 76% of the men and women who used Listerine Antiseptic and massage twice a day showed complete disappearance of or marked improvement in the symptoms of dandruff within 30 days.

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LAMBERT PHARMACAL CO., St. Louis, Mo.

THE TREATMENT

MEN: Douse full strength Listerine Antiseptic on the scalp morning and night. **WOMEN:** Part the hair at various places, and apply Listerine Antiseptic right along the part with a medicine dropper, to avoid wetting the hair excessively.

Always follow with vigorous and persistent massage with fingers or a good hair brush. Continue the treatment so long as dandruff is in evidence. And even though you're free from dandruff, enjoy a Listerine massage once a week to guard against infection.

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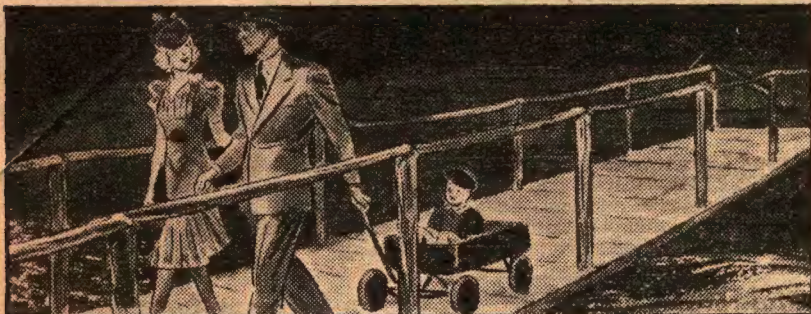
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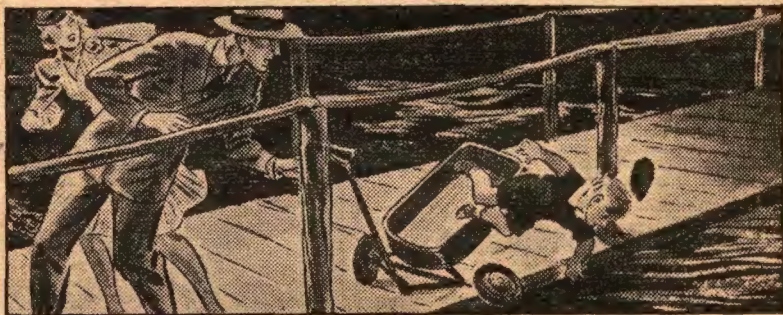
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NOT-SO-DAINGEROUS EXPERIMENT

It is generally considered unwise to light matches in a powder factory, and the point that lighting atomic fire in a world made up of atoms may be even more unwise comes up now and then. At this particular "now," when there seems to be a decent chance someone is finally going to be able to light an atomic match—Uranium 235 to be exact—the point is decidedly up.

For some hundreds of years men have been trying to change atoms. In the past fifty, they've been very diligently seeking to play with that particular kind of fire. So far, no one has succeeded in burning his fingers; the best approach has been one researcher's success in setting off some nitrogen iodide by the action of exploding uranium atoms. Inasmuch as nitrogen iodide, when reasonably dry, will, literally, go off if a fly lands on it, the success is not startling. Evidently, this world of atoms is pretty darned stable, fairly atomic-fire proof.

After all, it should be. To the best of our knowledge and belief, the planet was thrown out of the surface of the Sun, and that surface consists, so far as we can make out, of the ashes of something really violent going on inside. The Sun has, so to speak, heaved, writhed, and thrown out a few clinkers. Clinkers made up of ashes so thoroughly stable that, even when exposed to the fire of the Sun, they wouldn't crack.

Of course, there's almost always some fuel left in the ashes—but too dilute to be reactive, or worth bothering with. Uranium, thorium, radium, polonium—half a dozen of the heavier elements are still smoldering, and even capable of burning. But they definitely represent a badly diluted fuel. The fact that the latest experiments indicate that the fuel for atomic fire must be both concentrated and fairly extensive before reaction will become self-maintaining suggests that no wild atomic fires are going to get very far. Man's playing with atomic fire isn't quite analogous to matches, in a powder factory; it's more like an old flint-and-steel in an ash-dump.

That does not by any means mean you can't start a fire. A little scratching around that ash-dump and we can concentrate in one spot enough dry tinder to take fire, and enough fuel to keep it burning. But it won't, and can't spread.

Lord, if the Sun couldn't burn the blasted atomic slag, nothing man-made or man-started is apt to do anything very general!

That leaves, of course, the possibility that, while the fire may not be general, it may still be violent locally, and, man being small, general enough in his view to be disastrous.

Indications are, it won't. Once a U235 atom is primed with a neutron, it lets go almost instantly, they now believe. The reaction is some millions of times more violent, and some hundreds of thousands of times more sudden than the breakdown of a molecule of TNT. If you could once get all the atoms in a few pounds of U235 primed at the same time, the results would represent one of those very rare instances where the word "awful" genuinely applies. Fortunately, there is no co-operation between the atoms; those first primed go off before the rest have any opportunity to collect neutrons. The neutrons released are moving with terrific velocity, and must be slowed down by collisions before they can be captured. Under such conditions, it will burn, but can't blow up.

Which, considering Man's psychology, seems to be an example of foolproof engineering on the part of the Creator.

THE EDITOR.



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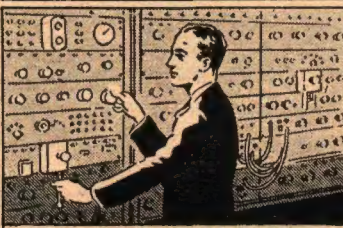
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COLD by NAT SCHACHNER

Cold—and lack of power—threatened two worlds, and five men who must be the arbiters, whether they willed it or not—

THERE were five of us on Ariel when the trouble started, not counting the Venusian troglos, who don't count anyway. They're squat and

bowlegged, with gnarled, powerful limbs and faces the general color and texture of old roots, and they do all the dirty work of the System. They

are especially good at mining and digging and they can handle a machine when it requires only a single, repetitious operation. But of brains or initiative they haven't a vestige. Fill up their bellies with pulka meal and give them a mouthful of the narcotic bassa leaf to chew on while they're working, and they're perfectly happy and submissive, no matter where they are.

Of the five who counted—so to speak—three were Earthmen and two were Martians. It had been a delicate problem, in a way, picking us five for the job. The allied governments of Earth and Mars had sweated blood before the personnel had been finally chosen. Diplomacy had to get in some pretty dirty licks, there were governmental conferences on Earth, then on Mars, then a big powwow on neutral Venus, and finally the five names were agreed upon.

Don't get me wrong, though. The wrangling didn't take place over Jimmy Vare, yours truly, of Earth. The Mining Explorations Council of Earth picked me because I had been lucky enough to be the first guy to uncover the armorium deposits on Ariel. Nor was there any dispute about big Bill Snead, who knows how to handle a crew of troglos like nobody's business. The two Martians were also the private concern of their own government. Sar-xtumph—or noises to that effect—was the ultimate authority on heavy elements, and they don't come any heavier than armorium. Ango, with a similar hyphenated string of unpronounceable syllables, made the fourth. He was a crackajack at fashioning new machinery and new methods to meet the almost insuperable obstacles of interplanetary mining.

So far, so good! No trouble at all

in making the selections. But it was the fifth who caused all the diplomatic squabbings. Who should he be—an Earthman or a Martian? And if so, why?

For look at the set-up! Ten years ago, when I was a wild, scatter-brained youngster with a yen for shoving a spaceship where no one else had been fool enough to go before, I had come to Ariel. And, with the luck that is somehow the birthright of all fools, I had found an outcropping of armorium, chipped off a few samples and brought them back with me to Earth for analysis.

Now, no one had ever seen armorium before in the flesh. It was a new element—they placed it as No. 99 in the atomic scale eventually—and it sure was heavy. But that wasn't all. The bigwig scientists of both planets got busy on the stuff, and discovered some remarkable properties. Its electrons were packed so tight that nothing could budge even the thinnest beaten plate—no acids, no alkalies, not the most powerful explosive or bombardment ray known to the System. Nothing, that is, except a certain limited range of very soft X rays. The first guy who turned on the juice, just out of scientific curiosity, went up with a bang. So did his lab and most of the town in which it was located. Luckily he had tried out his X rays on a bit of armorium about the size of a pea. If he had turned that particular wave length on an honest-to-goodness hunk he might have blown all Earth to smithereens.

For more cautious experimenters discovered an astounding fact. Armorium, impervious to every mighty agent known to the planets, collapsed into pure energy when a soft ray, of the order of 10^{-3} cm. wave length, was focused on it. Here was atomic energy with a vengeance. Sure, there

had been atomic energy before, but its release required tremendous machinery, millions of volts of power, and an energy output that barely topped the intake. Here, with a tiny X-ray generator worth only a few bucks and a modest electric current, energy was to be had for the asking. And it could be controlled, as investigators found out after a few more tragedies. A shift of a few millimicrons either way in the wave lengths of the X rays, and the speed of disintegration could be hastened or retarded as desired.

No wonder both Earth and Mars went haywire! With unlimited power on tap, with a heavy metal besides that otherwise could withstand the full impact of a planetary collision, all civilization had to be revamped. Within a few years armorium was an integral part of industry and science, of cultural patterns and human life. Take away armorium, and the two worlds would be in the position that Earth, let us say, back in the nineteenth and earlier part of the twentieth century, would have been without coal and iron. Sunk! Through! Washed-up!

Now maybe you can understand why the composition of the five-man Board of Supervisors who handled all operations on Ariel was so all-fired important. Why didn't Earth claim sole title, inasmuch as I, an Earthman, had discovered the stuff? Because a neat little clause in the Earth-Mars treaty of relations took care of that. A couple of centuries ago, when the first expeditions landed on Jupiter's moons, there had been plenty of trouble. Claims and counterclaims. Dogfights, and finally a bang-up war. When the smoke of disintegration dusted off the interplanetary ways, the sane men of both worlds got together. Thereafter, all

new discoveries, colonies, planets, et cetera, were to be joint property and jointly administered by five-man boards, two and two and the fifth by agreement.

It worked out swell. The Jupiter moons, the Saturnian satellites. No trouble at all. Then I had to go and light out for Uranus. Still no trouble, except for diplomatic finagling. For they finally agreed on the fifth man. Even the Martians, who naturally wanted a majority, agreed they couldn't have picked a better chap.

Enos Abbey is old in years and in honors, but his spirit shines like a halo around his white hair and wrinkled face. He's respected and loved as much on Mars as on Earth. He's a scientist of the first rank, an administrator second to none, and everyone is his brother—even the troglos. By this you'll suspect that I like Abbey—and you could double and redouble that. But then, I'm not alone in my enthusiasms.

We got along swell on Ariel during the years. Don't get any wrong ideas, though, that Ariel is the last word in summer resorts. It isn't. Imagine a huge hunk of slag just out of the smelters, jagged, splintered, brittle with razor-sharp edges where molten bubbles of metal have cooled and exploded, and you'll have a fair, if incomplete, picture.

No air, no water, no vegetation, no heat. Especially no heat. I thought I had known what cold was before I came to Ariel, but my ideas underwent a prompt and unpleasant revision. As the innermost satellite of Uranus, it's muchly distant from the Sun. In fact, the Sun is just another star out there—a mere point of light. Of course, it's far more brilliant—the light is about that of three thousand full moons as seen from Earth—so there's plenty of light.

But the temperature! An even two hundred and sixty-five below zero, Fahrenheit; except when Uranus eclipses the Sun, as it does regularly, when it drops another fifty degrees or so. It gets you finally, that cold. Even the spacesuits, heated with interior electric units, can't keep it out when you slog over the God-forsaken landscape long enough. We usually stayed put in our diggings in Sterile Valley, where we kept our labs, our living quarters and general storehouses. The mines themselves were about a mile distant, on the spur of what we called the Everlasting Mountains. That name was my poor idea of irony, for the troglos, in spacearmor, were digging them away at a tremendous clip. The armorium deposits outcropped on the spur, but every test we made showed that they angled deep down into the bowels of the little planet.

So everybody was happy. Earth, Mars, with a seemingly inexhaustible supply of the precious metal on tap, the troglos, their wide mouths and ample bellies taken care of—and us five supervisors.

We got along swell. Big Bill Snead, a blond giant with a slow, good-natured smile and an easygoing disposition, got along with everybody. Sar and Ango—we never tried to pronounce the second parts of their respective handles—were high-type Martians, and that means plenty. For the Martian nobles, as bred through a million Martian years, had refined into pure armorium. Tall, slender, with a slightly greenish cast to their narrow, elongated heads, with large, expressive eyes of a startling yellow, they were aristocrats in every graceful move, in every convolution of their intricate thought. Enos Abbey, as I have said,

could go out on the Martian desert and bring back the terrible steel-fanged xlars fawning at his feet. As for myself, I manage pretty well as long as no one tries to take a poke at my homely phiz.

We took turns on shifts. There were the mines to be watched, blasting operations to supervise, cargo boats to be loaded and supplies unshipped, television communication with the home planets to be kept in working order. But every thirty-six Earth hours we all got together. The thin twilight of day changed to a Stygian black, imperfectly relieved by a million sharp, icy stars and a dim, vast, mottled Uranus.

Then, while the troglos snored in their shelters at the mines, we let off accumulated steam in the underground chambers at Sterile Valley. It was warm there, we had a good library, canned music, certain creature comforts painfully accumulated over the years—and we talked. We talked, in fact, interminably; sometimes forgetting most necessary shut-eye.

You might think that was strange—five shut-in men finding things to say to each other after years of enforced, lonely comradeship, broken only by semiannual cargo ships. But we did. And never a quarrel, never even high words. We pretty much thought alike, but each had some facet he could illuminate for the others out of the recesses of well-stocked, nimble minds.

We talked about the daily routine, naturally; scientific problems and engineering difficulties involved. The eternal cold was also a topic, though we played it down by mutual consent after the second year. The troglos were always good for some anecdote—none of us quite considered them as human; except Abbey, of course. But we talked most of the

things that mankind has pondered over and never solved for thousands of years on Earth, and millions of years on Mars. The meaning of life, philosophy, the extent of the Universe, first causes, final dissolutions, space and time, history, the whys and wherefores, and the mysteries of comradeship.

Sar was especially eloquent on the last topic. He was a shade more vital, more vibrant than his fellow-Martian, Ango. Ango said less, but when he spoke there was meat in his words.

We had drifted in one by one to the big central dugout, each making sure as a matter of instinctive routine that the air locks were closed tight behind us; and shrugging out of our unwieldy spacesuits with a sigh of tired anticipation. The thirty-six-hour cycle was just ending, the troglol were snoring in the mines, dreaming of more bassa leaves and their mouths drooling in the process, and the deep excavations had settled into frozen quietude.

I stretched my long limbs luxuriously in the cozy warmth of the diggings, thawing out after a more than usually tedious job of prospecting in the icy canyons the other side of the Everlasting Range. It was the shift that no one liked—the cold burned into your bones, the savage landscape dipped in eternal twilight, the silence and the loneliness got you. Of course, we never uncovered any more deposits of the precious armorium, though iron and nickel were pretty plentiful—and some gold.

Yet the home governments had insisted. Though we were pretty certain that the lode we were working went deep and solid, the politicians back home were jittery. Suppose the stuff suddenly gave out. The civilization so carefully built on the founda-

tion of armorium would collapse over night. There was no substitute.

ANYWAY, I wasn't worrying about that at the moment. I had dutifully done my trick, and ten hours of time to call my own stretched ahead. I should have gone to sleep; so should the others. But you have no idea what the camaraderie of good, strong, loyal men means to one who has been cooped up on a savagely untamed, desert ball on the outskirts of the Universe for almost a decade. We craved each other's society like strong drink; we swore fealty to each other over and over—Earthmen and Martians alike—and we cupped our friendship with careful hands, fearful even to waste a drop.

Sar was holding forth as I allowed the grateful warmth to seep into my tired bones. Big Bill Snead sprawled in a chair, grinning lazily, reacting to the flow of words as a cat does when its fur is properly scratched. Ango, his slender, elongated head cocked to one side, seemed to be reserving judgment.

Sar said: "Look you, man is a reasoning being. It took him a long time to reach that point, but we've reached it. In the old days—I admit it for Mars as well as for Earth—the emotions ruled. Brute emotions, like hate, envy, greed, jealousy, lust for power. Of course they cloaked it with fine words, with rationalizations, but that did not matter."

"And today, those emotions have vanished?" Ango wanted to know.

"Of course they have. The last war anywhere on the planets took place more than two centuries ago. The worlds are organized on a rational, sensible basis. Earth and Mars are ruled separately, but they co-operate amicably, without argument. Our very presence on Ariel

is a symbol of that unity. I'm a Martian by birth, so is Ango; Bill Snead and Jimmy Vare are Earthmen, not to speak of Enos Abbey; but does that mean a thing to us? Do I think of any planetary distinction when we're together? Do any of you others?"

"Hear! Hear!" Snead murmured approvingly.

I rubbed my hands together with a sigh of content, and sank into a chair. "Where's Abbey, by the way?" I asked.

"Over at the mines," Snead told me. He lit up a pipe and puffed.

"Shouldn't he be back by now? It only takes fifteen minutes on the trail, and it's half an hour past closing time."

"You know Abbey. He mothers those troglos like a brood hen. I'll bet he's bedding them down, and tucking them in so's they won't catch cold. But Sar's right, Jimmy. That thing called patriotism is a thing of the past. We're all just men together, regardless of where we've been born or raised."

"I suppose so," I answered vaguely. My mind was on Abbey. He was an old man, and the trail from the mines was treacherous. Suppose he had slipped. Suppose—

"You suppose so!" echoed Sar indignantly. "Why, you blithering idiot, look at me. Could you even dream of hating me, of blasting me down with a needle ray just because I'm a Martian and you're an Earthman?"

I jarred out of my abstraction. "You old son," I told him affectionately. "I'd cut off my own right arm first. You're more to me than a blood brother. Sure, patriotism is the bunk, an outmoded irrationality."

"There you are, Ango," Sar said with a gratified air. "What did I

tell you about those primitive emotions?"

But Ango only grunted. For just then the thin *whoosh* of the outer air lock could be heard. I sprang forward eagerly. I had been silly to worry about old Abbey.

He came in now, closing the lock softly behind him. He stood there a moment, motionless in his space-armor, his face blurred behind the steamy mist that had already condensed on the outer surface of the glassite helmet.

I started to help him out of the clumsy equipment. One did little services for Abbey without a second thought. "I was getting worried about you," I said, as his soft white hair emerged in a cloud. "Thought you'd fallen somewhere and hurt yourself." I zipped him out of the baggy suit and he walked slowly forward to the visor set. His face had a curiously set look upon it, and he did not answer me. In fact, he hadn't said a word since he entered.

THE CONVERSATION died, the words of greeting stumbled and fell by the wayside. Sar stopped in midoratorical stride and looked funny. Ango cocked his head a little farther to the side. Snead sat up straight in his chair and stared.

This wasn't like Abbey at all. He usually came in, quick and birdlike for all his years, a warm, individual greeting for everyone who had preceded him, a beautiful smile irradiating the whole diggings with his personality.

"Hey, what's the matter?" Snead yelled. "One of your troglos get the pip?"

"Shut up, Bill," I grunted. "You know what Enos thinks of them."

But the old man did not seem to have heard. His long, wrinkled fingers, still deft and quick as those of

a surgeon, rested on the visor keys. His face had not relaxed in the slightest; his baby-blue eyes seemed to pierce the rounded walls of the subterranean quarters and fix on something far out in the Universe.

I took a quick step forward, laid my hand gently on his arms. "What is it, Enos?" I asked. "What has happened?"

He stiffened under my touch; then he turned slowly and faced us. You could have heard a feather drop. Everyone was silent; suddenly serious.

He took a deep breath. There were no preliminaries, no leading up to the news.

"It's the armorium lode," he said. "The troglos have come to the end of it in the No. 3 shaft."

Just that! Nothing more! But if Ariel had suddenly exploded under our feet and catapulted us all into space, we couldn't have been more aghast. No blueprints had to be drawn for any of us. We had lived with the mine for almost ten years; had lived, slept, breathed, with the thought of it in our minds. We knew every inch of it, every blessed outcropping. And we knew what that meant.

Ango was the first to recover himself. He always was. "Are you certain?" he asked, sort of dull and low.

"That's why I'm late," said Abbey. "I didn't believe it myself. When the troglos came chattering up to the office, I went down personally. I found that the drills were embedded in gneiss and lava. The armorium lode ended abruptly, as though it had been cut off. Still I didn't believe. I got the troglos back to work. The drills bit deeper. Perhaps another formation had been forced through the main lode by an ancient eruption. We went down

one hundred feet, working like mad." He stared at us with those soft blue eyes of his. "We hit nothing but lava and gneiss, the bedrock of the planet."

"But our instruments showed that the No. 3 lode went down for miles and miles," I protested.

"The instruments were wrong; or, rather, we interpreted what they told us wrongly. What happened was this: The gneiss and lava are mixed in the exact proportions that will give an electrical reaction similar to that of the armorium ore. It was one chance in a million."

Snead came heavily to his feet. "Then . . . then," he stammered, "that leaves only the No. 1 and No. 2 shafts. About ten thousand tons more of armorium to be dug out. We know exactly where they end."

Abbey nodded. We had worked out the figures about a month before; but they hadn't worried us any. That damned No. 3 vein was supposed to be practically inexhaustible.

"At the present rate of consumption in the System," I reflected aloud, "that means about a three-year supply."

Sar shrugged his slender shoulders. He even essayed a smile. "In three years," he remarked optimistically, "we'll find other veins."

But, even as he said it, the smile died. He knew, as well as we, that there weren't any other veins. Nowhere in the entire System. Don't think that the mining councils had sat back on their haunches while we worked Ariel. On every planet, on every satellite, on every measly little asteroid, the search had gone forward since that first discovery of mine ten years before. And everywhere they had drawn a blank.

No, sir, this particular vein was unique in the Universe; a sport, a freak in the cooling processes of a



"Now!" the Martian snapped, "your Earth-people have made as savage claims as any our own government made. They are not to be trusted either." And in his mind we knew he added—"Nor are you!"

barren little world; a quadrillion-to-one shot.

Abbey turned to me. "Any luck today?"

I spread my hands with an eloquent gesture. Not any luck today, not yesterday, not tomorrow, not ever. I was sufficient of a geologist to read the signs. We'd been practically all over the little twilight planet. There was only *one* tapping of armorium and that was now soon to go dry!

There was silence again. Every man was busy with his own thoughts.

And the more he thought the less he liked it. Three years' supply of the essential element at the most. Three years for an interplanetary civilization to reorient itself, to shift from a culture based on armorium to one based on primitive molecular power. A turning back of the clock.

"They'll never be able to do it," Ango said quietly. "The worlds are geared to quick, easy energy. Everything depends on it."

"They'll *have* to," I retorted.

"Of course," nodded Sar, regaining his resiliency. "The best brains of both planets will get to work on the common problem. In three years' time they'll find a new source of energy."

I was skeptical, but I kept quiet. After all, miracles have happened before.

Abbey opened the visor unit, sent out the first long dash that was our code signal to Earth.

"Going to tell the folks back home?" asked Ango.

"Naturally. They'll have to get started on their plans at once."

Now it takes some three hours for a signal to travel from Ariel to Earth—or Mars, for that matter—and three more hours for a response. So you can readily see that communication is lengthy, tedious and fraught with considerable difficulties. Therefore I will sort of telescope the conversations that took place, though in fact they extended over a period of several Earth days; and we went about our regular routine during the interval, leaving Enos Abbey in complete charge of the visor.

John Horner, congressional leader of Earth, is a man of few words. All he said was: "I'll convene Congress at once, and call you back." Then, as a sort of afterthought: "Don't notify Mars until you hear from me. This is an order."

But by the time the "order" winged its weary way through space, Abbey had already put through the call for Mars.

We were still around when that cryptic command came through. I could see old Abbey stiffen; Sar and Ango looked surprised.

"Now, what did Horner mean by that?" demanded Sar.

Abbey's baby-blue eyes were gen-

tle. "Maybe he wants to break the shock of the news himself."

Ango leaned forward. "What will you say to Titl when his signal comes?" he asked very quietly. Titl was council head of Mars.

It was Abbey's turn to look surprised. "Say?" he echoed. "Why, just what I said to Horner. Tell him the truth."

I could feel the relaxing of a certain tension then in both Sar and Ango. It was a curious sort of feeling, something I hadn't noticed around Ariel since we holed up together. I was angry. Angry with Horner for that stupid order, angry with myself for being angry. I was all mixed up.

We threshed the thing out, and finally agreed Horner had meant nothing by it.

Then the Martian response came through. Titl was even more cryptic than Horner. "Council will go into immediate session to consider what's to be done. Leave Earth to us."

"Now, what did *he* mean by that?" countered Bill Snead, his lazy, smiling eyes developing a certain glint.

"The same thing that Horner did," I shoved in hastily. "He thought he was the first one to be notified, and he could relay the news to Horner much faster than we could."

"Yeah, I suppose so," he admitted reluctantly.

But I wasn't satisfied. I didn't like it, but I kept my dislike to myself. Perhaps I was just jumpy, imagining things. It was infuriating—this business of six-or-more-hour intervals between answers. It gave one the impression of a slowed-up visor screen where the machinery went haywire and the guy at the bat is starting a swing at the ball and never getting there.

We kept on working right along. Life had to go on, and the precious

armorium became now infinitely more precious. We each dropped into fixed grooves, instead of shifting around as before. Each man took the job he was best at, and stuck to it. I myself suggested that I put in full time at further explorations. It was rotten work, tramping over jagged lava flows that cut even our steel-shod shoes to ribbons in short order, toiling over precipitous crags and descending into eerie gorges, always in dim twilight and sometimes in a blackness one could never conceive of back on Earth. Uranus was a brooding, monstrous disk overhead, tinged with apple-green—a world as fantastic as its tiny satellite, a mystery-shrouded planet whose core could never be pierced. Thousands of miles of gaseous, liquid and solid methane, ammonia and carbon dioxide overlaid that core.

Yet I stuck to it feverishly. The stakes were infinitely greater now. I fine-combed the tumbled landscape, bending over ungainly in my space-suit, flashing my hand-beam over the sullen rocks, checking with the sensitive reaction-instrument that hung from my neck like a locket, seeking always some sign that armorium might be buried beneath. Back-breaking, ungrateful labor, with the outer cold always boring through my heating units; yet I didn't mind. It sort of kept me busy and my thoughts from brooding.

Three years' supply! Two worlds in desperate need! It would have been far better if I had never discovered the damned stuff! Thoughts that were like squirrels chasing their tails interminably within the narrow confines of a cage.

On the fifth day we met in the central chamber. It was the first time all of us were present at the same time. But each man had secretly figured out for himself that

communications from the home planet were about due. We had heard nothing further since the response to Abbey's first report and the silence was maddening. So we drifted in, each pretending he was dog-tired and needed a rest.

I wasn't pretending, either. I could barely zip myself out of my suit. I had put in ten solid hours in the region of the Hell Hole—the name we put to it speaks for itself—and I could hardly stand. Sar was at my side immediately, offering assistance and a cup of hot coffee. I gulped down the steamy liquid and almost scalded my stomach, but I felt better then.

"Thanks, old boy. Any news?" I added casually.

He shook his head. "Not a thing. The home planets must be putting their heads together."

"They'd better," I said wearily. "I've searched and searched, and it's no go."

Old Enos surveyed us all. There was affection in that glance, clean understanding. Then his eyes deepened.

"Promise me," he said abruptly, "that no matter what happens, you'll all remain just what you are now—comrades, friends through thick and thin."

Big Bill was sprawled in his chair. "Why . . . hell . . . sure. There's nothing could tear us apart. We've been through too much together, the good with the bad. We know each other inside out. But what's the idea, Abbey?"

The old man went inscrutable on us. "Nothing in particular, Bill. But how about you others?"

We all spoke at once—a confused chorus that made a queer din of agreement. It sounded funny, in a way, grown men like us making pledges of eternal friendship, but it

warmed my heart and made me feel aglow all over. Good men and true, the kind you could rely on forever and ever. Nothing could break up this gang. From what I saw written on the others' faces, I knew they felt the same as I did. A love fest.

Old Abbey smiled as though in relief. His smile was beautiful to see. It was like a benediction gathering us all in.

THEN the visor set sounded off. The signal isn't particularly noisy—we only turn it on full blast when the last man quits the diggings—but we jumped as if a Jenkins bomb had smacked us.

Abbey was standing near the unit, so he thrust it open. The screen glowed. A picture formed on it. The Congress of Earth, with John Horner seated in the leader's chair. It was impressive-looking. The great world chamber situated on an artificial island in the Caribbean, with its white tiers of seats extending interminably up to accommodate the tourist hordes that usually attended the sessions of Congress. But this time the vast hall was almost empty. The visitors' seats were clean and bare. Congress was in secret session—the utter seriousness of the moment was unmistakably imprinted on each and every face of the three hundred delegates. John Horner faced us unseeingly. You can't have two-way vision when the electromagnetic waves that carry the vision take three hours each way to hurtle the gulf between you.

Horner was a heavy-set, florid man with bushy eyebrows and a face that masked his thoughts. Yet just now he was obviously excited. His fingers drummed on the tinted stellite desk at which he sat, and his eyebrows moved in individual spasms.

"Calling Enos Abbey, William

Snead and James Vare on Ariel." His voice was steady enough. He repeated our names. "This message is private and confidential. Please see to it that no one else is present. I am waiting five minutes. By that time you are to be alone." He repeated that three times carefully, then he stopped and waited. The congressmen sat rigid in their seats, making no sound, waiting.

We looked at each other and stirred uneasily. No one seemed to want to speak; but curious green flushes tinged the cheeks of both Sar and Ango.

Then Ango rose. "Come, Sar," he said steadily, "it is time for us to go."

We all spoke at once then—the three Earthmen. I remember shouting inanely that they were to stay if I had to knock them down in the process.

Bill Snead snarled: "Sit down, you chumps!"

But old Abbey's voice muted our sudden clamor. "It is a pity," he observed, "that we can't explain our position to Horner and Congress right now. He evidently misunderstands our status on Ariel. We have no secrets from each other. Whatever Earth wishes to tell us, must be told to all."

"Ataboy!" exclaimed Bill.

I made approving noises.

Sar and Ango stared at us, then at each other. The flush died in their cheeks. "Thank you!" said Ango softly, and sat down. So did Sar.

We all breathed easier, then turned to the motionless visor. I never knew five minutes could last so long. Talk about the relativity of time! I could have lived a couple of busy lifetimes in that interval while the beam-chronometer flashed off the seconds. No one said a word, we just sat there and waited.

THEN HORNER started to talk. He seemed to be staring straight at us—though we knew he couldn't see us, yet. "I assume," he said, "that only you three men of Earth are present. You will understand why this is vital as I go along. Your news, I need not tell you, was of the utmost importance. The System has relied upon your assurances that there would be a sufficient supply of the element, armorium, to last for many hundreds of years. The planets have acted accordingly; in particular, our own Earth."

He cleared his throat, and we fidgeted in a dead silence. We didn't want to miss a word.

"Now we find you have been mistaken. Now we are told there is only sufficient to carry the System through about three years. But Earth cannot shift back to primitive power methods in that short time. It would be disastrous; there would be starvation, suffering of the worst kind." He looked carefully at his fingernails. "There might even be a world revolution. People might think that Congress and myself had mishandled the situation."

A low susurrus of agreement made a wind through the delegates, and died.

"I never did like Horner," grunted Bill. "Thinking of his own hide, instead of making plans."

One would think that Horner had heard him. For he was saying: "Therefore, after lengthy secret sessions, we have come to certain conclusions. In the first place, it is obvious from your report that the blame for your miscalculation of the armorium deposits must lie directly with the two Martians on your Lord."

"What!" Sar bounded from his chair, his face jerking with anger. "He dares—"

Ango pulled him down. "Take it easy, my friend. Let us hear what further he has to say."

As for the rest of us, we sat there stunned, while Horner's voice rolled on.

"They misled you three Earthmen as well as ourselves," he continued smoothly. "No doubt they kept their home planet well advised, while we were completely in the dark. As a result, we have authentic information that Mars has secretly laid in a stock of armorium to last them for many years. They plan to force us back to primitive conditions, and then sweep down upon us with their hordes and eliminate us as a rival power."

"That's a lie!" screamed Sar, his mouth working.

"Of course it is, son," soothed Abbey. His eyes held pain, as though he had known in advance just what would happen.

The visor droned on. "Therefore," said Horner, "to safeguard our homeland, to protect ourselves against the machinations of these vile barbarians of Mars, Congress has decided on decisive steps. Even as I speak to you, a well-armed, well-equipped battle fleet is taking off from the rocket port of New York. It has secret orders to proceed full speed ahead for Ariel. In the meantime we command you as loyal, patriotic sons of Earth to co-operate with us. The future of our world depends on your efforts.

"You are to seize the two traitor Martians on Ariel, imprison them securely so that they may not warn Mars in time. Another thing. If, as we have information, the Martians are racing a fleet to seize the planet, you are to hold them off until we arrive to destroy the enemy. You have certain weapons of defense that were installed as a protection against

possible pirates. Use them."

Horner's face became grim, tense. "Remember, Earth expects every loyal son to do his duty. That is all."

The screen died. I heard myself saying dully: "My God! Have they gone crazy? This means war."

ANGO CAME slowly to his feet. His greenish face was almost white. His slender nostrils were expanded. He stared at us pleadingly. "You heard what your leader said. Do you believe that about us?"

Big Bill Snead's ordinarily good-natured face was a stormy thundercloud. "Hell, we know different. Horner's trying to propagandize us into something smelly. He's nuts if he thinks he can do it."

Sar was quivering like a racehorse after a swift, climactic finish. "But your Earth is sending a battle fleet," he cried. "They'll seize the mines, and then smash our Mars. It's . . . it's—"

"Don't say any more, son," Enos Abbey broke in softly. "You will regret it later. This is no time for calling names. We must put our heads together and decide what to do." His arm brought the two Martians, who had drawn a little apart, into our midst. "All of us!"

Ango shot him a grateful glance. His mouth opened to say something, when the signal burred again. "Ah!" he breathed. "They have changed their minds. They will countermand their instructions."

Abbey turned on the screen. "Here's where everything goes to pot," I muttered.

It was not Horner. It was Titl, head of the Council of Mars. He was alone in his private office high above the Great Central Desert. Fantastic murals, depicting the strang flora and fauna of the Red Planet intertwined in mortal combat, flamed on

the walls. Personally I could never see how any sane being could work in the midst of such nightmares, but the Martians didn't mind.

He stared out through the depths of his own screen unseeing at us. He seemed to be attempting to probe the secrets of our dugout, over a billion miles away on Ariel. He was taller even than Sar and Ango, and his general color was a deeper green. His eyes had a certain cold, piercing quality, and his lips were tight-compressed.

"Calling Sar-xtumph and Ango-qdwirk." How any mortal tongue could rattle off those tongue-twisters of names I never could understand. "This is private, for them alone. If you are present, please ask the others to leave. If only an Earthman is present, be good enough to call them at once and then permit us to be left alone. I shall wait ten minutes."

"Holy cats!" Snead ejaculated. He bowed ironically to the screen, then to Sar and Ango. "He's pulling the same gag as Horner. Shall we go and leave you to your tête-à-tête?"

"Don't be a fool!" Sar growled. "He has nothing to say to us that you can't hear. You are to stay."

Old Abbey sighed. "I expected you to say that."

Then we relapsed into silence again, sneaking each other sidelong glances. But our faces were eloquent of the turbulent thoughts within. This business was getting on our nerves. First Horner, now Titl. I braced myself for the shock when the ten minutes were up.

Sure enough, it came. I won't repeat everything Titl said to what he thought were the private ears of Sar and Ango. It was close enough to Horner's spiel to be its first cousin.

The burden of it was that us three Earthmen had pulled the wool over the eyes of the poor, trusting Mar-

tians; that Earth knew what was what all along and had finagled vast stores of armorium into their possession; that not content with such outrageous stuff, they were now sending a fleet to grab whatever was left, and then proceed to wipe Mars out of the System. But Mars was wise, and was jumping the gun. Even now a great Martian battle line of swift cruisers had taken off to get to Ariel first. It was the duty of Sar and Ango as faithful, patriotic Martians to jump us blankety-blank Earth scum unawares, so we couldn't pull any more dirty tricks. Then they were to put the defenses in order and hold off the enemy fleet until the brave Martian boys came galloping through space—blah—blah—blah!

Then he faded out in a burst of fervid hokum.

Sar and Ango just sat there gulping. Their vocal muscles seemed paralyzed.

I said: "Humph! This is where we came in before. Horner and Titl; Earth and Mars; six of one and half a dozen of the other."

"Did you boys believe all that twaddle?" Bill purred.

Sar shook himself. His large, yellow eyes blazed like an electric caldron. "Titl has gone crazy," he husked. "Patriotism! Love of home! Honor! Blah! He's just as bad as your Horner. They're both cloaking short-sighted, selfish grabs with high-sounding words."

Old Abbey positively beamed. "I'm glad you're all taking it this way. I was very much worried this past week, since we sent the news. I don't mind confessing now that I expected something like this."

"You did?" I yelled. "Then why didn't you let us in on it?"

He shook his head, and it looked like a soft snow going into action. "I was hoping against hope. I was hop-

ing that the politicians back home would forget their little localisms and outmoded methods and do what we five have been doing. Work shoulder to shoulder to solve this problem which confronts them for the common good."

Bill Snead sprawled deeper into his chair. His hands were in his pockets. "How much time have we before the rival fleets come tearing over here to take us apart?"

They all looked at me. I had served, when not more than a kid, on an old battle-ax, hunting smugglers among the asteroids; and ever since I've been supposed to be an authority on space navies.

"Well," I said judicially, "that depends. The cargo boats take anywhere from three to four weeks when the planets are in conjunction with us, several months when we're in opposition. Unfortunately we're pretty well in a line now. But they're tubs. The battle cruisers and space destroyers use the new Hutchins drive, and they literally burn up the ether waves. I'd say about ten days for the Martian crowd and another day for the Earth bunch—that is, if they took off simultaneously."

"Which they did," nodded Ango.

"Ten days' breathing time," said old Abbey. He was thinking aloud. "Ten days in which to decide what to do."

"Do?" retorted Bill. "There's nothing to decide. We tell 'em both to go plumb to Pluto. We're in charge of Ariel, and by the great horn planet, we intend to remain in charge. What armorium's left is an interplanetary trust, to be mined and divided for the benefit of all. No one planet is going to hog the supply."

"Bill is absolutely right," Ango chimed in. "Here on Ariel we are neither Martians nor Earthmen; we are citizens of the System. And, for-

unately, our defenses are excellent. They were made to withstand for months the shock of any attack from space."

WE WERE all on our feet then, shouting, pommeling each other like a bunch of kids. We were exalted out of ourselves, and we told the world about it. We were brothers, cosmopolitans, broad-minded guys. None of that provincial patriotism stuff for us. A Martian or an Earthman—what difference did that make? White skin or greenish? Ancestry or habitat? That was the kind of tosh that bred wars and devastating hatreds. That way lay the brute and the savage. We were too damned civilized to be taken in by a lot of propaganda hooey.

We exhausted ourselves finally to meet old Abbey's mild, but critical, eye. We sat down again, feeling a bit ashamed, but defiant just the same. That was the way we felt, and we had to blow off steam.

"I am proud of you all," said the old man. "You've reacted just the way I had hoped you would. But mere words and backslappings aren't enough."

"O. K.," I growled. "You take charge, and tell us what we're to do."

Everyone said: "Yes, that's right. Let good old Enos take over."

"All right," he said briskly. "If you wish it so. The first thing we have to do is to put our defenses in order." His smile was rueful. "We've not paid much attention to them these last few years. There was no need. But they were installed by the soundest engineers in the System, and I think they'll hold indefinitely. There's the impermo-screen of triple vibrations that will make a shell of force around the entire planet, and is impenetrable to any weapon so far

evolved. We have our space howitzers and needle rays, too, but we're not going to use them. After all, we don't want to kill men like us; we're strictly on the defensive."

"That's the ticket" I exclaimed.

He smiled. "Then we'll notify our respective home governments of our joint decision, and try to persuade them to call off this outmoded, barbarous war and get together like sensible men. And thirdly—and I think we'll find this the most difficult job of all—we've got to keep going just as though nothing had happened. The mines have to be run, cargoes made ready against the day of peace, and the troglos kept busy and satisfied."

"Them!" I said with a certain contempt. "The whole Universe could bust up as long as they get their daily quota of bassa leaves and they can dream about their native hunting grounds."

"You misjudge them," Abbey retorted with considerable heat. "They are human beings just as much as we are, with the same divine spark as we think we have. Their present degraded condition is our own fault. The first explorers who landed on Venus traded the vile bassa for their mineral wealth; and the rotten traffic's been kept up deliberately ever since in order to assure Earth and Mars of an obedient, servile labor supply."

It was the first time I had seen Enos Abbey so excited; so I said nothing. But everyone knew that the troglos were just one step removed from the animals, and there were those who even questioned whether it was a step up or a step down.

WE GOT to work at once on a carefully mapped campaign. We overhauled our defensive equipment. It was in a pretty bad state. But sev-

eral days of hard, intensive work put it into usable shape again. I'll never forget the thrill we got when we first tried it out. The underground caverns where the power was developed shook with shuddering vibrations, and high above the airless planet—about twenty miles, in fact—the screen gradually formed. It was a beautiful sight. Every color of the rainbow was in it, flashing and gyrating like gigantic northern lights back home. Yet it was so thin and transparent that the stars of space peered through with hardly a jot of their steady beams shorn. The giant Uranus seemed a vast, dim, oblate ball swathed in shimmering gauze.

"It hardly looks as though it could withstand a peashooter, much less a Jenkins bomb," observed Sar doubtfully.

"Don't worry," Abbey said with confidence. "The impermo-screen has been tested repeatedly. It's a uni-way affair. We can shoot out against invaders, but they can't penetrate it from the outside."

"But we won't try," observed Ango. "We're acting only in self-defense."

Then we talked turkey with the home politicians. No use contacting the fleets. They'd take orders only from their respective governments. And, anyway, our visor beams were not geared for their code wave lengths.

Just as we had expected, both Horner and Titl were at first incredulous, then furious. But we had hoped to break them down, and convince them of the error of their ways; especially after we told them about the impermo-screens.

Evidently we had misjudged them. Each was convinced of the probity of his course, and that the other was a scoundrel. They blistered us with

rage, with contempt, with epithets. That is, Horner directed his fire at the three of us Earthmen, and Titl worked on Sar and Ango. Then they switched to appeals and exhortations. They painted us pictures of conditions on our planets—of the men and women and children, the common, ordinary, everyday, decent people whose happiness and very lives were bound up in a continuance of the status quo. Once our armorium supplies are exhausted—and their voices really quivered with emotion, there was no fake about it—everything collapses. We go back to the brute. Your own people, those whom you loved, relatives whom you left behind, will suffer. Picture the dislocation when our subatomic energy fails, when we have to fall back upon outmoded sources that can't supply a tenth of what our world now requires for daily life. The strong will trample the weak; ruthless men will arise and seize power; millions will die.

I confess that I felt a bit squirmy when Horner painted us his picture. I remembered with a shock that I had a sister somewhere in the city of Iowa. She had been a tousled kid when I hit the spaceways, but the pictures she used to send me showed a gracious, lovely woman now. And she had two youngsters, one of whom was named after me.

I saw Bill Snead slowly clenching and unclenching his huge fists. It hit him, too. His folks back home were pretty old, and they depended a lot on the slice of pay that he sent them regularly.

It was just the same when Titl took the floor. Sar and Ango stared down at the floor. They also had relatives along the Martian canals. Titl pulled a fast one. He brought the whole bunch of them to the visor-screen, and they begged and im-

plored their far-off sons not to let them down. I growled a bit under my breath. That wasn't sporting. After all, old Horner hadn't done anything like that. Of course, he had told us about what would happen. And it was true—every word of it. No one could deny the facts. But to pull cheap propaganda the way Titl did—

I caught myself short, bit my lip. Steady, old boy, I warned myself. It's not Sar's fault or Ango's. We're all friends out here, swell guys together.

ABBEY ASKED pertinent questions of Horner and of Titl. Of course, a lot of the effect was lost because it took over six hours to get answers. The result was we practically forgot what was asked when the answers came through.

"Suppose," demanded Abbey, "you get a monopoly of the remaining supply of armorium? Suppose you win the war and crush the other planet? At the best there would be a six-year store for you singly, instead of three. Won't the same terrible things happen at the end of that period? Whereas if you get together—"

We perked up eagerly at that, and nodded to each other wisely. Good old Abbey! He put his finger on it, all right. We even looked at each other again frankly, smiling.

But damned if Horner didn't have the pat answer! He shook his head sorrowfully. "We thought of that ourselves," he told Abbey. "Before we took any steps, we put it up to the council of technicians. They reported to us that, given six years and working at top speed, we might possibly change over to the old atomic output system without a too disastrous dislocation of world economy. In three years, however, that

would be impossible. Those extra years spell the difference between collapse and success."

Titl, of course, rather lamely said something to the same effect. But he was smart enough to forget to point out that since there were much fewer inhabitants on Mars than on Earth, the change over could be made much more swiftly.

I said as much to Sar and Ango. And they almost bit my head off!

Sar's face was distorted; he foamed. "You talk like a blithering idiot," he howled. "You forget that the natural resources of Mars, as the older, longer civilized planet, are much smaller than yours."

"So you think you fellows are more civilized than we are," I began with cold dignity.

"Sar didn't mean that." Ango put his oar in. "But it's true about the natural resources; and in any event, suppose our population is smaller? Don't you think they'll suffer just the same?"

"Meaning, I suppose," Bill said sarcastically, "that when one Martian suffers, it adds up to the sufferings of two Earthmen."

We were all on our feet by this time, glowering away like a bunch of Kilkenny cats. Then Enos Abbey poured oil on the waters.

"Quarreling won't help matters," he said quietly. "You're acting in exactly the same fashion that the poor, propaganda-infected people of the home planets are acting. The four of you are men of sense, of understanding. Have you forgotten so soon the vows we took, the camaraderie of ten years?"

He went on in that vein for some time, and we gradually cooled down. I thought to myself: "Good Lord! but you're an idiot, going off half-cocked at good old Sar and good old Ango."

We started to feel pretty much ashamed of ourselves after a while, and we shook hands sheepishly all around finally, and swore we'd never get hot under the collar again.

Abbey sort of smiled benediction, but I noticed a strained expression under the smile. As though he were afraid of us!

WORK went on—mining, exploration, and all that. Four days had passed since war had been declared; four days while the converging fleets raced along the spaceways toward us.

I kept thinking of that all the time while I stumbled, lonely and aimless, over the bleak terrain. It was merely by instinct, by the routine habits of long usage, that I kept poking with my metal-sheathed rod at the crusted lava and took endless readings on the reaction-meter. I was positive there wasn't another deposit of armorium anywhere in the Universe. So I had plenty of time to think.

Suppose we did hold off the fleets. There'd be a dogfight out there in space just the same as soon as the two caught up with each other. I pictured that fight. Great Jenkins bombs ripping out the guts of beautiful cruisers, spilling their human contents like bloated insects into the empty frigidity of space. I had seen a man once fall through an air lock whose slide had become unfastened, and the thought of what he looked like still made me sick. Earthmen—the pick of the planet, husky, smiling, comrades of other days—going to destruction under the vicious fire of Martians.

And back home! I closed my eyes and almost went catapulting down into a gorge that went practically into the bowels of the planet. I saw our big cities, teeming with millions, laid waste under the swooping assault of the enemy. Little children,

innocents, of our own race! Their reproachful eyes began to haunt me; I saw them everywhere; in the twilight-purple mountains, in the cold mockery of the stars, in the slow wheeling of Uranus.

I swore savagely at myself within my helmet. I took myself in hand. "You'll go nuts," I lectured myself, "if you keep this up. We're doing the right thing. Sar and Ango—"

I stopped short. Yes, Sar and Ango. Suppose they decided they were Martians first. Suppose, under their friendly, open countenances, they were plotting. It would be easy enough, when their fleet came hurtling along, for them to open the screen.

In spite of my heating units, the cold-made tissue paper of my armor. I trembled all over. A blinding light struck me. By the long tail of the comet! I saw it all now. Those two babies had already fixed things, were even now laughing at us up their sleeves. No wonder they had agreed so quickly when I suggested I'd take the exploration shift, and that big Bill Snead would go to the mines!

It fitted in so beautifully. Ango was in charge of the all-important impermo-screen, and Sar had to do with the storage of the mined armorium. The two vital spots where they could betray us! Sure, Enos Abbey was permanently in our quarters, sort of supervising. But he was an old man, they could jump him without any trouble.

I wheeled around instinctively. The shadows of the Everlasting Mountains were ominously black around me. I thought I saw something move among them. My heart began to pound. Suppose one of those damned Martians was even now trying to sneak up on me. The airless waste would bring no sound.

With a curse I thrust up my metal-

tipped rod. We carried no weapons—there had been no need of them on Ariel. There was no question about it now, someone was hurrying over the narrow trail from the mines, coming lickety-split, a wavering wraith in the gloom.

"Stop where you are!" I cried, holding the rod threateningly, and sprayed my beam. There were tiny communication units in our helmets.

The figure had poised with ungainly arms outspread as if to hurl itself on me. Then the light splashed all over it, and a voice, filled with relief, buzzed in my ears.

"Jupiter, but you gave me a scare, Jimmy."

I lowered my rod with an equal grunt of relief. "Not saying what you did to me, Bill. For the moment I thought you were one of the Martians."

"Yeah?" Through the glassite helmet I noticed how deadly serious Bill's ordinarily good-natured face was. "So *you've* got the idea, too?"

"What do you mean?"

"Well, up there at the mine, I got to sorta thinking. About the war and good old Earth, I mean. Then I began to notice the funny looks Sar would slide at me when he thought I wasn't watching, every time he'd drop into the mine. He'd talk to the troglos, and break off suddenly when I'd come within earshot. I looked him straight in the eye, just to show him he wasn't pulling the wool over me. About half an hour ago, he makes some lame excuse and hotfoots it for our quarters."

"He did?" I exclaimed.

"Yeah! And the more I thought of it, the less I liked it. What if those two birds've been playing us for suckers, with all that hooley about us being citizens of the System? What if they've decided to betray

us to the Martians? After all, *they're* Martians."

"They *are* Martians," I said slowly.

He caught my padded arm with his flexible mitt. Urgency peered out at me. "They're back there—the two of them—alone with Abbey. The old man couldn't do a thing against them. They could—"

I wasted no more words. "Come on, Bill," I ground out.

WE WENT hotfoot over the dim trail, our steel-shod shoes jarring the jagged terrain into little sparkles of fire. We burst into headquarters gasping and running little rivulets of sweat. We barely thought of closing the air lock behind us as we ripped through.

Old Enos Abbey seemed backed against the wall. Standing close to him, taut and grim, were the two Martians. They whirled as we came catapulting.

Enos cried out: "What's the matter? What are you two boys doing here?"

I gripped my rod firmly, pulling off my helmet with my free hand. "Have they started anything?" I cried.

Sar and Ango exchanged quick glances. They edged toward the bin where some assorted metal bars were stacked. Sar said bitterly to his partner: "You see, Ango. You wouldn't believe me. These Earthmen thought to catch us unawares. It's lucky I came."

"Well, I'll be blasted!" I puffed. The colossal assurance of him flabbergasted me. "You were the first to sneak away from your post. We only came to make sure you weren't pulling any fast ones."

Bill growled, and Ango snarled. We stood there, all set to mix it.

Old Enos stared sort of aghast.

"Stop it!" he thundered. I never saw those mild blue eyes of his shoot fire before, but they did now. "Are you all crazy? First Sar and Ango come with a fantastic story about how they're afraid you two are plotting to turn over Ariel to the Earth fleet. Then you two barge in, intimating the same nonsense about *them*. Are you all the same men who only a few short days ago vowed eternal confidence in each other? Is the cold of this planet freezing common sense and common friendship, too?"

I did not relax my hold on the rod. "We played square!" I snapped. "But they're Martians, and I would not put it beyond them to play along with their own kind."

Ango was a dirty-green. "Sar was right. All Earthmen are alike," he snarled back. "Except Abbey, of course." He bowed in his direction. "But the rest of you let narrow patriotism and provincial hates becloud whatever civilized faculties you may have once possessed."

Bill Snead took a step forward. "Why, you . . . you—"

Well, it took Abbey a long time to bring us to a point where we wouldn't scrap it out right then and there. We finally agreed to a coldly sullen truce. We even stumbled out some apologies for what we had said about each other. But all the palaver in the Universe couldn't make me trust those Martians any more. Abbey was right; the cold of Ariel had frozen any friendship. It was all right for Enos Abbey—poor, trusting soul—to take their protestations at face value. I knew better. And so did Bill. He whispered as much to me. And that went double, I suppose, for what those birds thought about us. I could see it in their faces.

After a deal of discussing back and

forth, we finally reached a *modus vivendi*. I was to go to the mines with Sar, and Bill was to stay with Ango at the impermo-screen. That way we'd be paired off all the time—Earthman with Martian—so we could watch each other for any sign of treachery. Old Enos didn't count. Bill and I naturally knew he was all right, and the Martians seemed to trust him, too. Abbey was that sort of a guy. Suspicion just couldn't cling to him.

He tried his best to argue us out of it, but it was no go. Finally he quit, but he looked pretty sick over the situation. He just moped around and looked at us with sad, reproachful eyes.

Bill whispered to me: "Don't you worry about headquarters, Jimmy. I can handle Ango any day in the week."

"And Sar won't be able to pull a thing," I promised.

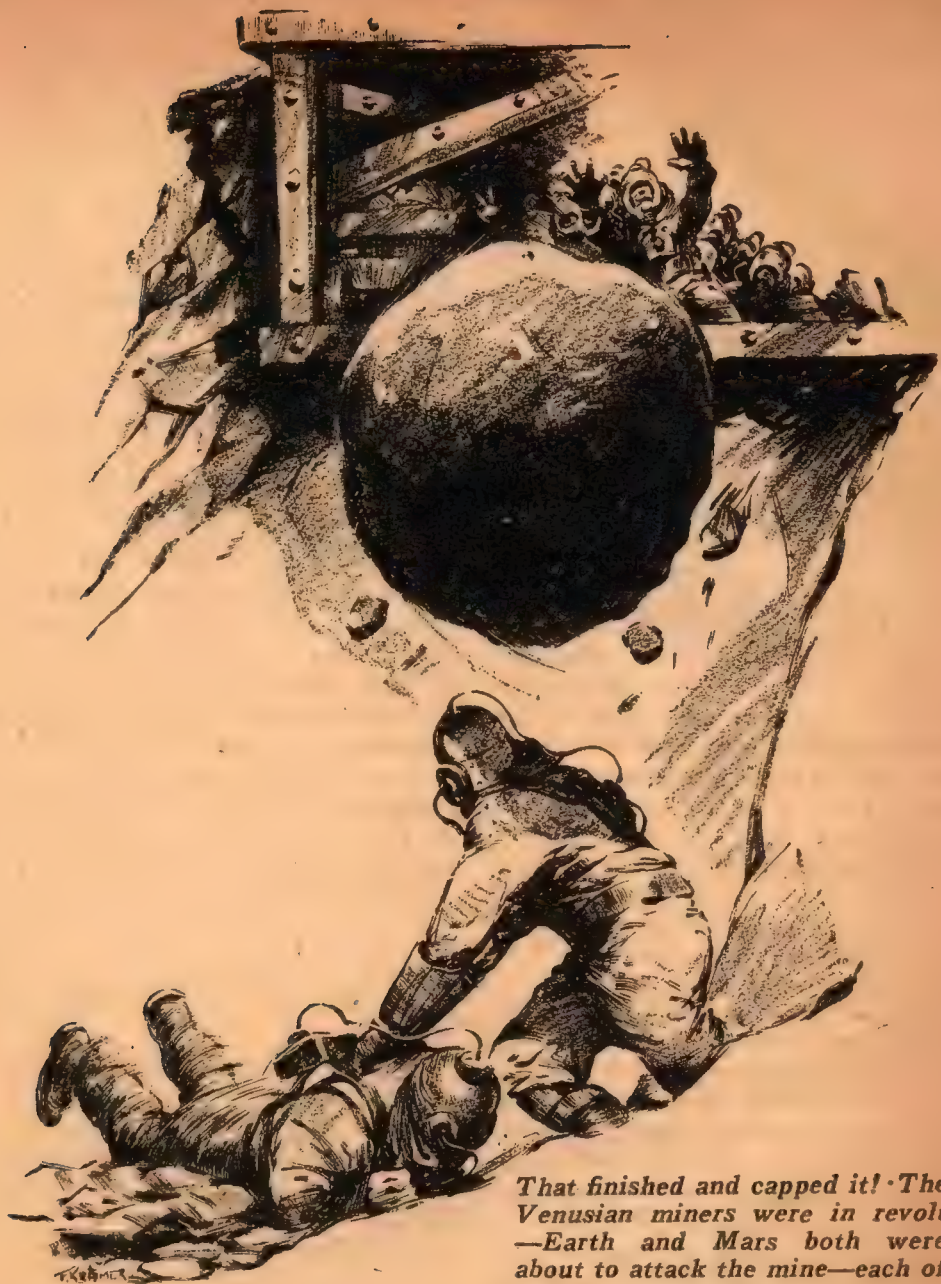
But before we started for the mines—Sar and I—Ango said loudly: "Let's get this straight. As far as headquarters are concerned I trust Enos Abbey to see to it that nothing untoward happens. But out there at the mines, there'll be the two of you." He looked at me peculiarly. "I want it definitely known that both of you—Sar and Vare—are to return here for the sleep period *together*." He emphasized the last word.

Before I could say anything, Bill cut in. "That's O. K. with us. Either both come, or neither. If I catch sight of just one coming up that trail alone I'm turning the needle gun on him."

"Regardless of who that one is?" Ango demanded pointedly.

"Regardless."

IT WASN'T pleasant. The days passed, all of us keyed up to the breaking point, watching for the



That finished and capped it! The Venusian miners were in revolt—Earth and Mars both were about to attack the mine—each of us was watching the other—

least untoward move. At the mines, where I went Sar was right at my side. When he went to talk to a troglo, I stuck to him like a bur. It was funny that we didn't once think

how all this was affecting the troglos. The squat, deformed Venusians blinked at us with their great, staring eyes and chattered to each other in that guttural jargon that no human

being has ever been able to decipher. But then, neither one of us considered them as fellow creatures, or that it mattered much what they thought.

So we kept circling warily around each other all the time, and spoke only when it was absolutely necessary. We sure were formal with each other. Naturally the work suffered. The troglos lazed along, doing minimum, and their chattering increased.

Sar got sore. He said to me with cold formality on the seventh day. "The troglos require a lesson, Mr. Vare. I suggest we cut off their supply of bassa leaves."

That was about the worst punishment we could hand out to the Venusians. Take away their food supply, and they wouldn't mind as much. "Suits me," I growled.

The days became a nightmare. None of us relaxed a moment, especially as the time grew near for the fleets to arrive. We didn't even have the consolation of knowing what was going on back in the home planets. Old Abbey kept the visor-screens resolutely closed. "You men are close enough to each other's throats now," he said, "without getting madder because of something that happened on Earth or on Mars."

But he forgot we had imaginations. I brooded about it. I saw all Earth a shambles; my sister dead and the two little boys with their brains dashed out. At such times I had to clench my teeth to keep from strangling Sar. I'd glare at him, and he'd glare at me with added interest.

The troglos went about their work sullenly. We had told them they'd be without the bassa for a week, pending good behavior. They muttered a good deal among themselves, but we didn't care as long as they kept on working. Besides, our minds were elsewhere. And each sleep period we trudged back together, silent,

making sure that we were abreast as we came up the trail toward headquarters.

The tenth day came. The tension became almost insupportable. Already our electro-scanners had caught sight of the hurtling space fleets. They were coming up fast, angling toward Ariel at a terrific clip. About a hundred million miles separated them, and the Earth fleet had a slight lead.

Bill Snead forgot himself and let out a whoop when Abbey told us the startling news. If looks could kill, then the glares that he got from Sar and Ango would have stretched him out flat.

"Remember our oaths," Abbey appealed to us desperately. "We keep them both out, no matter what happens."

"You just heard Snead," muttered Ango. "What guarantee have we that when the Earth fleet pulls in—"

Old Abbey straightened his stooped shoulders. "I'm taking care of the impermo-screen alone," he snapped. "You and Bill are to remain in the common chamber. Do you trust me?"

"Sure!" declared Bill heartily.

Ango hesitated. "Yes," he said at last.

"All right, then. The first fleet will make contact in about five hours, Mars in about six. I'll be ready for them both. Meanwhile, get along on your jobs, Sar and Jimmy. You're late."

I didn't want to go, but one could not disobey Abbey that flatly. Sar trudged moodily along, keeping even pace with me. Not a word passed.

URANUS was a big, very thin crescent now, and the tiny Sun was close to the rim of the giant planet. There would be an eclipse shortly. What

did that matter, though? In a few hours hell would break loose.

As we turned the last spur over the Everlasting Mountains, which hid the mines from us, I was suddenly aroused from my abstraction.

Three shafts had been dug into the lava facing. The tunnels slanted into the bowels of the mountain gradually, following the lodes. For a part of the way they were open borings; at each, about a hundred feet or so down, air locks had been installed, so that the troglos could work without spacesuits.

We were late, and by this time the troglos should have been going strong. There should have been little cars of ore trundling out of the depths to the smelters we had installed close by. Smoke should have been pouring out of the stacks and congealing into frozen particles immediately on hitting the airless cold.

But nothing stirred. Everything was dark and quiet in the shadowed twilight. Not a sign of a troglo anywhere, not a sign of life.

I quickened my pace. "Damn those troglos," I growled. "You can't trust them a moment. I'll bet they're still snoring away."

"They're sore because we took away the bassa leaves," said Sar.

"They'll be still sorer when I get hold of them," I snapped, and lunged forward.

In the semidarkness I did not see the thin metal wire that had been strung taut across the trail. It caught my shin, and I went over with a crash. My helmet struck sharp lava. Stars flashed all around me. Luckily glassite is tough; but the jar stunned me momentarily.

In my daze I managed one thought. What a swell chance this was for Sar to jump me!

Then I heard exultant screams,

barbarous shouts in strange gibberish.

I twisted my head and stared upward. My heart stopped beating.

No. 3 shaft, which had been unused ever since the vein ran out unexpectedly, opened up on a ten-foot rise just above us. Out of its mouth swarmed the troglos, squat in their space armor, shoving before them an enormous rock.

Their broad, root-colored faces were triumphant behind their glassite helmets. Their thick lips smacked resoundingly within my receiver. The huge slab of gneiss poised over the rim. Behind it a dozen troglos heaved. It tottered.

I stared upward in horror. The rocking mass looked like a mountain to me. Even in the lessened gravity of Ariel it must have weighed at least a ton. When it fell, it would make a direct hit. I'd be squashed into a mess of mangled flesh and bone.

I tried to rise, to fling myself out of the way. But that cursed wire they had placed as a trap had twisted my ankle. And I lay in a shallow trough, so that I'd never make it.

Funny how many thoughts can race through a chap's mind when death breathes down his neck. Little incidents of my boyhood; a green, smiling field back on Earth; rage at Sar for having inveigled me into depriving the troglos of their precious bassa; a sick sensation that now Mars would triumph.

The rock began to fall, soundlessly, but all the more terrible in its silent rush. I closed my eyes. The bravest man in the Universe couldn't face death like that with his eyes open.

My shoulders wrenched violently. My spine twisted until it almost snapped. I felt myself whirling over and over like a spinning toy. The breath *whooshed* out of my body.

Then there was a terrific concussion. As though an earthquake had ripped through the little planet. And complete silence!

I WAS AFRAID to open my eyes. What had happened? Why was I not dead? Why didn't I hear the yells of the troglos any more?

Gritting my teeth, I forced my leaden lids open. I lay sprawled close to the edge of the trail, flung about a dozen feet from where I had first fallen.

The great rock had made a direct hit, all right. The stretched wire was ground deep into the sharp-crueted lava underneath. It still teetered back and forth on its unstable stance. A hundred pieces, of all shapes and sizes, ripped off by the terrific crash, lay on every side. And above, staring down at me with wide eyes of disappointment, were the troglos.

The sight of them drove every other thought from my mind. The dirty little beasts! Who'd ever have given them credit for such cunning hate? I jerked erect, heedless of the pain that went through my ankle like a hot surgical knife, unmindful of the fact that my body was a mass of aches all over. I'd show those damned Venusians!

Furiously my mittened hand went to an outside pocket in the space-suit. I brought out a small, dun-colored sphere, twisted the little screw that held it safe. I drew back my arm to fling it.

The troglos screeched in fear. Or rather, I saw their mouths open; the communication set in my helmet had been smashed by my fall. They knew what I had. They had seen it in action many times in the mine.

The sphere contained penta-nitro-toluol, the most powerful explosive known in the System. There was

enough inside to tear down several hundred cubic meters of the most recalcitrant lava or gneiss.

They turned tail and ran like the fleet agrus of their native land back into the depths of the shaft. I could have caught them all in one great holocaust, but somehow my arm stayed poised to let them escape. After all, from their point of view, we had been brutal tyrants, treating them as something not quite as good as an Earth horse or a Martian dino.

I let them go, the fear of their native gods in their hearts; but I couldn't permit them to come out again after they regained their courage and take another crack at me. So I waited until I was sure they had scampered through the lock into the main body of the shaft; then I let fly.

The explosive did a good job. It blew in the whole face of the spur, burying the entrance under several solid feet of tumbling rock. That would keep the Venusians jailed until we decided what we'd do with them.

Then, as I turned painfully on my ankle, I thought for the first time of Sar. I found the Martian lying motionless and white a little way back on the trail. A flying fragment had pinned him down by the leg. Even as I heaved remorsefully to free him, I was crying out: "Sar, you old son, forgive me! You saved my life at the cost of your own. You shoved me out of the way, and paid for it. What a blithering idiot I've been! What damn fools we've all been!"

He opened his eyes then, and smiled weakly at me. He couldn't hear a word I was saying; his own set was smashed as well as mine; but his pain-twisted smile showed me that he knew that I understood.

"You're alive!" I whooped joyously. "Can you get up? We've got

important business together back at headquarters."

He rolled his head slowly to one side. His hand pointed down at his right leg. I looked, and knew what had happened. Within the flexible material of the spacesuit the leg was crushed or broken. He wouldn't be able to walk; he'd have to be carried—and gently.

In despair I hobbled around him, leaning heavily on my metal-tipped rod as a staff to ease the pain of my ankle. It was a mile of nasty going on the trail, and I couldn't lift him, even in that lessened gravity, without having my own leg crumple under me.

Sar made signs to me. I could see he was suffering; his face was pale underneath the glassite. But I was to go to headquarters and warn them of the uprising, so the others could take whatever measures might be necessary.

"All right, old fellow," I said heartily, though I knew he couldn't hear. "You just stay put and I'll have them back in a jiffy with the rocket car, and you'll be packed to camp as though you were in bed."

We only used the rocket car for long trips over Ariel, rarely for this short run. It accelerated too fast, and there were landing difficulties. "And don't worry about the troglos," I added. "They're safely holed up."

He grinned at me affectionately; then he fainted.

I STARTED back over the tortuous, jagged trail. It was terrible going. My ankle must have been swollen to triple its normal size; and though I leaned heavily on the rod, every step was exquisite torture.

The shadows had deepened suddenly, and a weird purplish gloom settled over the fantastic terrain. I looked up. The tiny Sun was just

going into eclipse behind the gigantic shoulder of Uranus. We had seen plenty of eclipses out here, but the sight of one always sent definite tingling along my spine. It was awe-inspiring. The quick drop in temperature—about sixty degrees in as many seconds, as the light cut off. The already glacial cold took on an added terror; the heating unit in my spacesuit required immediate stepping up.

Shivering and cursing my luck I stumbled wearily along. Within an hour or two the rival fleets would swoop down upon us. God knew what would be the upshot. And Sar was lying out there on the trail, helpless, alone, slowly freezing in the frightful cold. I was more than halfway down the trail; otherwise I'd have turned back to help him switch on more heat. An eclipse lasted several hours. But it was better now to press on and get help.

It was a nightmare journey. The weight of my lamed foot became more and more unbearable; every step sent waves of pain over me. But I kept on. At last I saw the low lift of the observation dome over headquarters. It was built of visceex sheathing, proof against radiation and stray meteors. In its rounded sides two thick quartz windows peered, with small, round slides through which needle guns could be thrust and sealed in instantly against escape of air by liquid sealing cement.

I forgot my dragging foot and raced forward with renewed vigor. In a few moments now the rocket car would go *whooshing* to the rescue:

Only quick action saved my life. I saw the sudden thrust of a needle gun out through the quartz, the pale-green, bitter face of Ango behind it. I dropped as though I had been shot

behind a ragged outthrust of splintered lava. The next instant a needle of brilliant light passed directly through the spot where I had stood.

Cold realization flooded me. In my haste, in the warming knowledge that when the test had come Sar had been a true pal and comrade, and not an enemy Martian, I had forgotten that the others, locked up in the main camp, still distrusted each other, and us; that a pact had been entered into. *I had come back alone, without Sar.* To Ango that meant but one thing; that I had slain his fellow Martian, and that there would be two against one to destroy him also.

I shoved my head out from behind the shelter, and gesticulated frantically. In a momentary glimpse I caught sight of Bill Snead, his good-natured face lean with horror at my single presence, distorted with inner struggle. I knew Bill. He had agreed to kill either of us if we came back alone; he would live up to his word, no matter what it cost him.

Then I ducked back frantically. The needle gun loosed its long lance of death. The rock in front of me began to sizzle.

I cursed. Time was pressing. Sar lay dying up there on the trail; sooner or later the troglos would dig their way out; and space war would break out in not too many minutes.

Yet every time I flicked my head out to try and make them understand what had taken place, that damned needle gun smacked at me. Ango was determined, and a good marksman.

At last I gave up, and started working frantically to fix my communications set. It took tall doing. I had to wriggle my hands free of their incasing sleeves and work with stiffened fingers in the cramped con-

finer of the spacesuit. Luckily it was only a matter of a loose wire, but tightening took almost half an hour.

Then I started to talk, frantically, in hot haste. Ango wouldn't believe me. He thought it was a ruse on my part to gain admission so that between Bill and myself we could overcome him. But Bill finally got hold of Enos Abbey and brought him up from his vigil at the screen. Perhaps he believed me; perhaps he didn't. He looked pretty sick over it. Anyway, he decided that the matter should be investigated, and prevailed on Ango to stop taking pot shots at me.

But he wouldn't let me inside. Ango was taking no chances until he saw Sar.

"Get out the rocket car," I cried. "You can come back with me, Ango. That's fair enough."

"Oh, no, it isn't," he retorted. "The fleets are due any minute now; you'd have Snead in control of the screen. Enos Abbey will go with you; I stay here with Snead."

AND THAT'S the way it went. We overshot the mine several times. You just start the car and it hits a hundred-miles-an-hour clip in the first second. But after much maneuvering we managed to land on a little plateau just before the mine.

We hurried out—at least Abbey hurried; I could only hobble. We found Sar still in a faint; but Abbey, after a practiced look, said: "He'll be all right. It's shock, chiefly, and the cold." For an old man he was pretty strong. He lifted the Martian carefully on his shoulder and placed him in the warm interior of the car.

Then he turned and waved to me impatiently. "Hurry, Jimmy. We've got to get back. There's no time to lose."

But I had painfully scrambled up among the shattered rocks where I had tossed my explosivé charge. I wanted to make sure that the troglos couldn't get out until we wanted to let them out. I was feeling pretty humble about them anyway. Abbey, mildest and kindest of men, had blistered me for what we had done. So my consçience was bothering me.

I heard Abbey's hail, but I didn't stir. Nothing in the Universe could have stirred me just then. The pentanitro-toluol had ripped off a great gash in the overhanging spur. And there, shining softly back at me in the eerie purplish light of the eclipse, ran a thick vein of phosphorescent armorium ore!

The old man came back impatiently. "What's the matter with you, Jimmy?" he said. "Are you star-struck? Sar needs attention, and I'm worried about what Bill and Ango will do while we're gone."

I just stood there, like a fool, pointing.

He took a quick glance, then he, too, became rigid. "Armorium!" he gasped. "The lost lode! Then our calculations *were* correct. It's just that there had been an upthrust of gneiss that split the lode. Only, instead of splitting it clean, as normally happens, it twisted it completely to one side."

He grabbed my arm. He was shaking, and it wasn't from the cold.

"Do you realize what this means?" he said hoarsely. "There's enough armorium down there to last for centuries."

I nodded dumbly. I couldn't talk, I was so filled up inside. There'd be no war, civilization could go on. Everything was all right again.

Then alarm seized me. "Hey!" I cried. "What about those war fleets?"

AST—3

"Leave them to me," Abbey declared confidently. "I'll—"

We both squinted upward. The black sky, in which a dark, ominous Uranus hung like a huge black disk, with the Sun completely hid, began to shimmer. Flashing colors chased each other over the vast expanse, thin and pearly opalescent. Like a faint, jeweled haze an arching shimmer of force spread over the darkling planet.

"The impermo-screen!" we said simultaneously.

Through the haze we could see the stars, and a closer cluster of tiny, fast-moving gleams.

I took a deep breath and tried to keep my voice steady. "The first fleet has arrived. It may be the Earthmen, or—the Martians!"

Abbey chuckled. "It doesn't matter. Bill and Ango have kept their word. They'll keep both of them out until we arrive."

"And then—"

"I'll tell them the story of our discovery on the beam-signal. I'll invite them to send down a single scout ship apiece to see for themselves. The reason for fighting is gone. There *must* be peace."

I stumbled blindly down the trail toward the rocket car. My flash illuminated the trail, but I could hardly see. My eyes were blurred with tears.

Strangely enough, it wasn't so much the thought of peace that made my eyes brim over like any kid's; it was the thought that the five of us were once more friends, comrades, strong and loyal with the bonds of years of toil together.

Just then a flash of light blazed out from behind the rim of Uranus. The purple darkness flushed with delicate hues. The eclipse was over.

It was at once a sign and a token for the future!



IN THE GOOD OLD SUMMERTIME

By P. Schuyler Miller

Illustrated by R. Isip

Joe Guilder loved heat. Even the heat of a Venus summer, he was sure, wouldn't stop him and his grand dream of empire. From crook to king! But the drying of a mud-puddle—

It was hot. Sweat ran down Joe Guilder's cheeks in little rivulets. It soaked into his bushy red mustache and dripped from his cloven chin. It gathered in the pouches under his little coffee-colored eyes and

brimmed over to course through the gutters along his vulture's nose and past the corners of his pursed-up mouth.

But Joe didn't mind. He liked it hot.

Besides, it wasn't so much the heat that made Venus unbearable for most people. It was the humidity. The rays of a swollen Sun fought their way through a miles-thick cloud blanket and were trapped. The planet stewed. Curls of vapor rose from every patch of water. Fetid mist crawled over the jungle, rank with the stench of rotting vegetation. Huge insects buzzed heavily past—carrion-feeders most of them—following the freshest clue to death.

It was the tag-end of winter, and men who had been brought up on snow and bitter winds and crisp, starry nights longed for them and cursed the fool's errand that had brought them to Venus in the first place. But Joe Guildler lay back in his tattered deck chair and let aches and agues and bad temper stew out of him while he watched through half-closed eyes the lithe movements of the golden-bodied *kru*-girl who was his current body slave.

She was different from the others he'd had in the past few months. She had a name, he supposed, but he'd never bothered to learn it. He called her Annie, and she answered to it quick enough. What was the sense of learning a gabble that was all chucks and titters when you could use good English? The *kru* understood it fast enough, and if they didn't they soon learned.

Guildler had been in the native village for three months and he was a king and a god. That was how things should be. It was the white man's destiny to lord it over all others, only back on Earth they were

getting ideas about world brotherhood and internationalism, and it was only in the outposts that you had a common sense code working to the advantage of them that had the guts and brains to use it. Among the *kru* Joe Guildler was top man. And summer was only just beginning.

Joe spread his thick legs and let his arms dangle at the sides of the chair. With one piggy eye he watched the adventures of a bright purple fly as it explored the folds of his naked stomach, and with a sudden impulse caught it with a snakelike swoop of his hand and rolled it between thumb and forefinger. The act roused him. He craned his neck.

"Annie!"

She was at his side instantly, her round face beaming. She was damn near as pretty as a human girl and a lot more obliging. Joe had a kind of fondness for her that he hadn't had for the others. There were times when he almost agreed with the school of biologists who argued that the *kru* were to all intents and purposes human, and then they'd do some damn fool thing and he'd relegate 'em to the frogs.

Annie was built as like a woman as you'd get. She had webbed feet and hands, and a moist, golden-yellow skin that the professors claimed was evidence of an immediate amphibian ancestry—whatever that was. He'd come over with a professor who did nothing but talk about it, hour after hour, until in self-defense Joe got into a poker game with a couple of sweat-gang hunkies and the second engineer, and damn near lost his pants.

"Annie—*goola* now!"

She bobbed in the curtsy he'd trained into all the *kru* wenches. They'd been a heathen crew till he

got here and taught 'em what manners they had. Give him time and he'd have 'em ready to step up to the Old Queen herself!

He took the great rosy fruit that the girl brought him and buried his strong teeth deep in its luscious fragrance. He champed, slowly and thoughtfully, gobbets of the milky pulp clinging to his mustache. Its honey-sweetness lay just under the waxen rind, but the creamy inner flesh had a spicy tang that hit the spot.

He gave Annie a bit of the *goola* pulp and she cooed happily and patted his fat jowls. He ran his own hand thoughtfully over his chin. He needed a shave. Might as well get at it—a man as busy as he couldn't afford to lie around all day.

THERE was time for a look around before he got down to the unpleasant necessity of scraping his chin. He sauntered down the dirt path from the king's house toward the sprawling native village by the river. They'd never thought of huts until he showed 'em how to make one, but they were clever with their hands—damned clever—and apart from a certain lack of planning he had a neat and pretty a little village as you could want to see. You had to make allowances, of course. The *kru* could make houses, but not all of 'em had learned what they were for. You'd still find 'em sleeping under a tree, or out in the bush, or maybe lined up under the eavesdrop when it rained. They liked water the same as he liked heat.

They were as clever as monkeys when it came to imitating. The first explorers found that out almost as soon as they set foot on Venus. The *kru* were normally vegetarians, living on fruits and water tubers, but when they learned to snare and

spear some of the less dangerous denizens of their native jungles, they were as apt as not to kill until they'd piled up a heap of game ten times as big as anyone could need. Then they'd forget about it. If the stench got too much for them, they could move. Without fire they couldn't cook the stuff, and finding something to burn in the sopping tangle of plant life they lived in was a practical impossibility.

Joe kept an ever-burning coal fire going in the king's hut, partly for the prestige it gave him, partly because he preferred the taste of roast lizard to raw fish and swamp grass, and partly because he liked to huddle over it on days when the gray rains came and it grew as close as Venus could to being cold. As far as he knew, it was the only fire within miles. And it was his business to know about such things.

His bare feet slapped the wet clay of the path with a kind of swaggering goosestep as he marched down between the double line of warehouses where the *kru*-men were at work. There had been none of this when he arrived three months ago. He'd come here because this particular village was bringing in the best quality *zinn*. Now they were bringing him not one herb but ten, and all of 'em in demand back on Earth. The stuff grew wild in places the *kru* knew about, and once they'd gotten the idea that he wanted it the rest came automatically, but he was playing with the idea of farming to raise the yield and improve the quality of his product. His grandfather on his mother's side had been a farmer, back home in England. This summer he'd get them started on it.

"Hai!" There was a patter of flat feet on the path from the river and a *kru*-man bumped his flat head duti-

fully on the ground at his feet. "O king—two man come!"

"What man?"

"Pack man. Pack man and new man."

The *kru* could learn as good English as anyone, but he'd taught them a pidgin that gave him a feeling of superiority. It was the kind of talk a native ought to use. He gathered that a trader was approaching, and that another man was with him, and, although it was ahead of schedule, he decided that it must be the Yankee, Cookson. Cookson wasn't a man you could impress easily, but the stranger was an unknown quantity. A man must keep up appearances in these things.

"Tell Annie now. Quick-o! Bring king's seat—great chest. Go now!"

The man pattered off ahead of him toward the thatched "palace." He followed more slowly. The lap-cloth of office would make it unnecessary for him to change his filthy ducks for new whites. Cookson wasn't worth the trouble, and they'd never last the interview out in any case. The humidity took all the crease out of a pair of pants before you'd been in 'em five minutes. He barked at two or three of the foremen as he passed the stacking sheds, and they followed him at a suitable distance with certain of their men.

The king's chair was set out on the house porch when he reached the top of the hill—with the chest in front of the chair for a footstool. He'd carved them both with his own hands, them and the hideous rod of office that replaced the string of skulls which the *kru* had given their fear and respect before he came. Annie was there with the king's cloth—a many-colored sarong with a six-inch, knotted fringe. He mopped his purple face with it and tucked it into the top of his pants. Dropping

down in the great chair he set his bare feet firmly on the top of the chest, took the staff in his left hand, and waited.

GUILDER HADN'T long to wait. Presently they appeared at the river ford. It was Cookson, as he'd supposed, but the other man—a youngish fellow with a lot of spaceburn—he didn't recognize. They'd sweat that burn off him if he stayed on Venus long. Men's faces grew soft and white under the eternal clouds.

Cookson knew the ritual. He stopped a hundred yards down the trail and waited for Guilder to speak. Joe motioned to the chief foreman. "Bring these man welcome."

They were little runts, the *kru*. Joe noticed that the foreman barely reached to Cookson's shoulder as he handed the trader a bowl of the prescribed fruits. Cookson gave one to his friend and bit into a swamp apple himself. In the code according to King Joseph I. that meant they'd accepted his welcome and were coming as friends. He knew and they knew what they were here for, but he spent hours thinking up the little formalities that set him apart from the herd, and he wasn't going to have them flouted.

Cookson had no patience with formalities. The man was an American, one of a family of traders which had its roots away back when America was just the back yard of an English king, and he knew Joe and Joe's little tricks. He came to the point at once.

"You've been busy," Cookson observed dourly. He was a thin and uncomfortable-looking man, and his tones were apt to be acid.

Joe, for the moment, didn't offer him a chair. "I'm always busy," he agreed. "What's got into your kit now?"

The trader flung down the half-eaten fruit. "Hodge here's my agent over east of town. Fifty miles from here. Now he comes in empty-handed. Claims his natives are fetching their stuff here to you. What about it?"

Guilder's smile was bland and friendly. "It's a long story," he said. "You may want to sit down. Annie—bring ice kit, quick-o!"

Ice was one of Joe's kingly prerogatives. He liked to be hot outside but cool inside. The portable refrigerator, hooked to the power line from his generator up at the damn, was one of three on Venus. Cookson took his drink grudgingly, the younger man with more enthusiasm. Joe sat and sipped and watched the trader twist and squirm impatiently.

But Cookson couldn't stand it. "You've gone too far, Guilder!" he snapped. "You're up against the law this time—white men's law. I made the first trade claim on that tribe, and the law will back it up for me. You may be king here, but you can't lord it over the whole bloody planet!"

Guilder drained his glass and held it out for Annie to refill. He lifted it and stared through slitted eyes at the pale-green fluid. "Is that why you came?" he inquired. "To tell me that?"

"It's reason enough!" Hodge lurched to his feet. "I was making a living out there. I came to this hole to make one, and if any fat swab thinks he can take it away from me, he'll have to guess again. Cookson staked that claim, fair and square, according to law. It's his—and mine. You keep your dirty hands off!"

"My hands have been clean enough to hand a fortune to your friend, Mr. Cookson!" Joe's voice

was smooth, but it cut. He was annoyed with this brown young man. "Mr. Cookson was willing enough to have me improve conditions among these unfortunate natives. It's paid him well. Where's your complaint?"

"I can do all you can and more!" Hodge retorted. "I *was* doing it, until you cut in. Cookson may be content to let you get away with it, but I'm not. If he won't defend his claim to the tribe, I will. They're mine! So keep out!"

"Mr. Cookson," the oil was thick on Joe Guilder's tongue, "I'll deal with you, if you don't mind. We understand each other. We can do business together without rancor."

"It's true, though!" The trader's scowl had deepened. "They're our tribe. The law says so."

"Mr. Cookson!" Joe considered the dwindling level of the liquid in his glass reproachfully. "The law is very explicit and very fair. I have the utmost respect for its provisions. But Mr. Cookson—what is a tribe?"

THE TWO MEN stared at Guilder blankly. He smiled. "If you will read the law more carefully, gentlemen, you will find that a tribe may change its status. There were certain marriages two weeks ago, between the women of my people and the men of yours. My girls are very charming young ladies, and suitors come here from great distances. There have been other marriages as well. And you must remember that according to the custom of the *kru*—which is very properly respected by the law of which you speak—a man is of the tribe of his mother—or of his wife. This is a very big tribe now, Mr. Cookson. Extraordinarily big when one considers the difficulties of communication between its various centers. I am afraid that my overhead will have

been substantially increased by this romantic adventure of Mr. Hodge's young men. There will have to be slight changes in the schedule of prices to which we formerly agreed. Annie—book now!"

"You fat toad!" Hodge was halfway to the throne when Guilder raised the staff. The young trader looked into the muzzles of a double line of rifles, new and glistening with oil, in the webbed hands of a dozen grinning yellow *kru*-men. Guilder took the huge ledger which Annie had brought him, and leafed over its pages nearsightedly.

"Yes. I fear that there must be an increase of at least twenty percent in our future dealings, Mr. Cookson. Perhaps in a month or two—at the end of summer—it will be possible to reduce prices again. I am contemplating a number of new improvements—roads, canals—things which will make communication quicker and easier. Civilization is a great blessing to these simple people, Mr. Cookson."

"Twenty percent!" The trader's mouth worked as though he were chewing cotton. "I can't pay that. My own profit's less than that as it is."

Joe smiled. "I'm afraid you underestimate me, Mr. Cookson," he said gently. "You can charge what you like—as can I. The romantic attachments of which I spoke have been *very* widespread. I can safely say that I control a practical monopoly of the various herbs and other things in which you have been interested. If you are willing to continue our arrangement on the new terms, I feel sure you will not lose by it."

Cookson seemed better pleased. "A monopoly, eh? Well—I've got a monopoly on those things!" His

gesture took in the line of rifles. "My prices will go up just as fast as yours do, *Mister Guilder*."

"You are a business man, as I am," Guilder acknowledged. "I am willing to make any reasonable agreement. But remember, Mr. Cookson—there are many dangers in the jungle, and there are many, many other traders who would be overjoyed to have your opportunities to make their fortunes."

Hodge had been staring at Guilder with a frown on his dark face. Now he stroked the side of his jaw slowly. He was smiling. "Just a minute," he said. "I've been remembering something—something very interesting. You may be able to set your own prices in dealing with Mr. Guilder and his monopoly, Cookson. Or you might prefer a half interest in fifty thousand dollars."

"What do you mean?" Cookson sounded incredulous. "What do you remember?"

"Just a face," the other told him. "I was in the Patrol once. There was a cheap English crook—a small-time thief and confidence man who worked gullible and trusting tourists in London and on the Continent. Things grew too hot at home, so he shifted to New York and stepped out of his class to lift a cool million in diamonds from some dowager trying to act like a subdeb. They had me on the case for a while before my term ran out and I came here. One of my old pals showed up in port just before we started out here. They traced him to Venus—and then he disappeared into thin air. I think he might be very glad to meet our friend the king of the *kru*. What do you say—Joe Murdock?"

Joe was hunched forward in his chair like a gluttoned vulture. His pig-eyes glistened. "I say those—

and those—and those!” At each sweep of his staff a new line of rifle-men rose out of the lush herbage. “I say a thousand like ’em, and more coming in every day to learn the same tricks they’ve learned. I say cases of rifles like those that Cookson’s traded me at his own pretty prices, and others like him who weren’t so damn sure he had a monopoly on the gun-running business. I say Joe Guildler’s king of the *kru*-men and he can be king of all Venus if he wants to! By the time summer’s over I *will* be king of Venus, and you puffed-up swabs will dance a pretty jig when I pipe for you. Tondo!”

The tallest of the natives bounced forward, wriggling like a pleased dog.

“Show these man gun-hit. There.”

His stubby finger indicated a spray of huge scarlet blossoms that swung from a bough halfway to the river. Tondo’s grin widened; he lifted the rifle lovingly to his shoulder. *Spang!* A single scarlet wafer drifted down. *Spang! Spang!* Two more petals followed it.

“THEY’RE clever with their hands, and they’ve got eyes like hawks,” Guildler sneered. “Anyone of ’em can drill a man through the eye as far as he can see. And I’ve got a thousand of ’em waiting for the word ‘Go,’ and a hundred a day coming in. They like to learn white men’s tricks, and I like teaching ’em. So—I wonder whether you’re going to sit down like a little gentleman and do business with me, or whether you’re going back to town with crazy ideas about some poor forsaken fool called Murdock who likely never saw Venus in his life?”

Cookson shrugged. “He’s got us, boy,” he admitted. “We’ll never get out alive if we don’t play his game,

and there’s a fortune for both of us if we do. You don’t know he’s Murdock, and you’d never get the Patrol in here past that army of his to prove it. He’ll be reasonable, Joe. We both will. What’s it matter who a man was once, when he’s top of the heap now?”

“Annie!” Guildler was beaming now. “Ice-o! Two man drink now. Make it chop-chop!”

He raised his glass solemnly. “Here’s to our very pleasant relations in the future,” he proclaimed. “Here’s to success for them that can take it, and confusion to them that can’t. And here’s to the months that’ll make Joe Guildler the biggest man this rotten planet ever saw—to the good old summertime!”

There was a queer glint in Hodge’s eyes and something like a thin smile on his brown face. “Summer! Yes—of course.” His eyes fell. “You’ve never spent a summer on Venus, Mr. Guildler?”

“Me? No.” The fat man looked at him in surprise. “Cookson can tell you—I’ve been here three months to the day. Three months—and what man has done more in thirty years?”

“A very remarkable achievement, Mr. Guildler. Remarkable!” Hodge wagged his head like an owl. “Drink up, Cookson. To the good old summertime!”

Joe didn’t like the look on his face, or on Cookson’s either. They seemed immensely pleased about something. He boosted his prices another five percent out of spite and Cookson took it without a murmur. Bearers were loaded with the baled herbs and started on the thirty-mile trek to the ramshackle village of iron huts that was the white man’s capital “city” on Venus. Joe watched it all from his carved throne on the

steps of the king's house. Then he swung his short legs up into the seat of the throne and bent over the great chest which he had been using as a footstool.

"Step up here, Mr. Hodge," he said disarmingly. "You know these natives. You're a veteran here, and I'm just a rank newcomer. But did you ever see the likes of this?"

He heaved up the heavy lid. Hodge stared at a mass of yellow metal—pure gold—hammered into broad, thick bracelets, into massive rings, into chains of crooked links. Cookson hefted an arm band, beaten out of raw gold and scratched with a simple design.

"You'd get more if you didn't waste time with this fiddle-faddle," he said sourly. "Train 'em to bring the stuff in raw. I won't have to melt it down then. I can't sell this."

"Bless you!" Guilder laughed. "They don't know anything about gold and I don't want to teach 'em. They saw me making myself a pretty out of a bit of the stuff I'd picked up in a certain place, and before you could turn around they were all at it. They bring 'em here to me when they're done, to show their affection. It flows in like the river yonder—and it flows out again through your fingers in exchange for things I have a fancy for. What's wealth, gentlemen, but the ability to reach out for the things you've a fancy for and to take 'em for the asking? Like Annie here. She could be solid gold and I'd think no more of her."

Cookson peered up at him. "I'm loaded down as it is," he said, scowling, "what with the stuff you've been stealing from Hodge and the rest. I can't be bothered with this stuff."

Joe chuckled. "A man after my own heart," he approved. "No gold fever in your veins. Take a souvenir

—with my compliments. Here, a gold bracelet for some wench you fancy, Mr. Hodge. And here's a fine chain to hang your watch on, Cookson. Remember me by 'em—and no hard feelings." He mopped his dripping brow. "Good day, gentlemen, and good luck. It'll be summer when I see you again, and I trust there will have been no unpleasantness in the meantime. We're all friends together here—friends and white men—and we must think before we act."

He watched them to the river bank before he beckoned to Tondo. The *kru*-man came pattering to his side and knelt at his elbow. Guilder pointed with his staff, and the native grinned. Gently he raised his rifle. It coughed—twice. Guilder waved his staff imperiously.

"Go look," he ordered. "Bring gold stuff. Make horn now."

Two of the *kru* went to search the trader's bodies for the gold he had given them, while Tondo brought out the huge purple snailshell which was Guilder's trumpet of command. It bellowed its summons out over the jungle, and presently the first of the bearers appeared at the far side of the river. The bales of herbs were safely back in their sheds before the two men returned from searching the pools below the ford. One of them had the golden chain.

"One man no," he announced regretfully. "Water take. Fish eat now."

Joe nodded placidly. Fish would indeed eat the too-alert Mr. Hodge when the rapids of the lower river tired of rolling him over knife edges of upended shale and dragging him through tangles of splintered roots. The bracelet was a small loss. By the end of summer he'd have a hundred like it in the chest. Someone

would surely be along sooner or later to find out what had become of Cookson, and if he turned out to be the right sort they might make a deal. Or they might not. Joe felt that he could well afford to let his trading go for a time and spend the summer months building up his empire.

AS THE PLANET swung closer to the Sun, the heat increased and as it grew hotter, Joe Guilders's feeling of well-being went up proportionally. He rarely remembered the two busybodies he had had to dispose of. He was too busy. And, anyway, they had had no business raking up the dead past. Joe Murdock had ceased to exist, and Joe Guilders was a king, and between the two there could be no connection.

During the last weeks of the rainy season his plan of empire progressed swimmingly. Every village within hundreds of miles was neatly sewed up in the matrimonial network which his nimble mind had conceived. Huge mass weddings took place in front of the king's house. Teaching squads went out to spread the good word. And, with a rapidity which surprised even its author, the Guilders plan for civilizing the *kru* spread over most of the explored section of Venus.

Summer had begun before he noticed a change, and then it did not worry him especially. Game was growing scarce, and the fruit on which he lived almost entirely tended to be overripe and tasteless, but he kept a gang of foragers busy potting at everything edible. Even so, as the weather grew hotter and drier it became evident that the food supply was not going to hold out. Moreover, the herbs on which his economic structure was founded were

withered and coarse. He only shrugged and put his packers to work hammering out gold doodads or drilling with rifles.

What did disturb him eventually was the fact that fewer and fewer natives from other villages came to trade or bump their heads at his feet. It annoyed him, for as his own store of energy increased it was disappointing to have no one or nothing to vent it on. The new diet of white man's bread and canned beef did its bit to make him restless and peevish. Now he spent hour after hour at his big, warped roll-top desk, planning intricate coups which would leave the Patrol and the white government gasping, and bring him out on top of the world, master of all he surveyed.

Joe was clever with his fingers, and he knew that the *kru* could copy anything he showed them. He began to experiment with simple machinery that might be turned to use later for placer mining, or in his own gun factory. He set up a small shop, and began to train the most promising of his men. But one by one he found that the villagers were drifting away into the jungle and vanishing.

One day the Sun broke through the clouds. Pacing irritably along the catwalk of the stockade he had built around the village after Cookson's visit, Guilders saw the shaft of light cut down through the bluish mist that lay over the jungle, like a solid bar of milky radiance. The forest no longer steamed; every leaf and twig was dry as tinder. The river was a mere muddy trickle, and the flow from the pond which ran his generator had stopped completely. At half a dozen points along the horizon smoke clouds rolled up from jungle fires, smolder-

ing in the thick duff, and Joe's placid brow began to pucker with apprehension.

He lay in the thick dark, during the short nights, listening for the jungle sounds that he no longer heard. The smell of smoke was in the air, and a dry, pungent odor of crisped leaves. The mud of the river bottom stank and there was the rancid stench of the native lamps he had to use, now that his power had failed him.

His ears grew keener during those sleepless nights. Twice he slipped from his bed to catch men and women of the village slipping over the stockade. They had come back, shamefaced and sullen, refusing to answer his questions. Where were they going? Who was bribing them away? No native had appeared in the village from outside in more than three weeks, yet somehow messages were getting out, somehow they were winning his people away from him, leaving him helpless and alone. The thought frightened him.

He had his bed moved in front of the gateway of the stockade, and lay at night with a rifle under his hand. During the bright, burning day he squatted on his carved throne, set high on a platform of logs where he could see the entire village. Annie seemed uneasy like the rest. Nor would she tell him what was wrong.

No man could go without sleep forever. The *kru* knew that, and they waited until he did sleep. He dreamed—Hodge's brown face grinning out of the shadowy depths of the forest; Cookson's dragged beard pointing at the sky; regiments of men in the black uniform of the Patrol closing in on him, advancing grimly in the face of the withering fire of his sharpshooters.

GUILDER WOKE suddenly, shivering. The gates were open. Annie and Tondo were straining at them, pushing them shut. Behind them he glimpsed moving yellow shapes, glistening in the half-light of dawn. They were escaping him!

His first shot caught Tondo in the shoulder; his second drilled the *kru*-man through the spine as he turned to run. Annie was huddled on the ground, her scared moonface turned up to him, blubbing. He shoved her out of the way and plunged down the trail after the fugitives, taking a snapshot at one scampering figure that somersaulted into the dry undergrowth and lay still. He stood and listened; bare feet were pattering madly through the gloom, and he fired blindly after them.

They were gone. Annie was all he had left. He stared at her truculently. She might have run away with the rest, he supposed—she and Tondo both—but something had held her. They were all alone now—a king and queen, without any subjects!

The Sun rode higher, looming like a vast, flickering gold piece through the mists. By noon Annie lay panting like a dog in the scant shadow of the king's house. Joe, stripped to a clout, paced the porch of the hut and tried to think.

He couldn't last the summer out alone. He had food enough, but the water was nearly gone, and, anyway, Annie couldn't live long on white men's food. Still less did he dare venture near civilization. If Hodge had been able to recognize him, there were others who would be only too glad to turn an honest penny by informing on him—him, Joe Guilder, king of Venus!

He'd been a damned fool; that was the size of it. He'd had no idea of

what summer on Venus meant. He was the greenhorn who had succeeded in beating the jungle—up to a certain point. He remembered the smirk on Hodge's face when he boasted of his plans for the summer. He knew! He deserved what he got, the stinkin' swab!

Guilder stared with bloodshot eyes through the haze that hid the forest. It wasn't too late yet. Apparently his people had migrated to some place where there was food and water in plenty, where summer didn't burn the jungle to a crisp and dry up every stream—where a man could live and work and plan. They were like animals. It was in their blood, and they'd gone, like birds back home on Earth. If he'd had the brains of a toad he'd have packed up and gone with 'em. But he had Annie still. She knew where to go. He could follow 'em yet!

With strips of matting and baskets he made packs for them both. He put in the few things a king might need to retain his royalty, and stuffed every available inch of space with tins of food. He could barely swing the pack to his back. Annie's might be too heavy, though these native wenches were as strong as horses.

He left her pack outside the door and strode into the dark interior of the hut, where she lay disconsolately in the corner, breathing in great sobs. Her shoulder seemed cold and lifeless under his hand. He shook her gently.

"Annie," he whispered, "we go, too, now. We find your people. Come now."

She stopped breathing. He felt her round, inquiring eyes staring at him through the shadows. He took her limp hand. It was still cool, still moist. "Come," he said. "We go now."

She danced madly around the hut. Then like a homing bee she darted past him, out the door and down the path, oblivious to his shouts.

GUILDER TROTTED after her, cursing. She'd come back for her pack or he'd have the yellow hide off her! He bellowed after her at the top of his voice, but her slim figure was off like an arrow, through the gate and up the trail toward the pond and the forest beyond.

He struggled along, his ungainly pack bumping and swaying on his shoulders. One strap broke and the basket spilled into the dry weeds beside the trail. He left it there and pounded after the girl, gun in hand, yelling angrily. Then he saw her, waiting at the end of the natural dam where he'd set his power house. She waved at his shout; vanished into the mist, then reappeared and stood teetering from one foot to the other as he lumbered up the hill toward her.

She came a little way to meet him and danced on ahead, tugging at his hand. Her eyes were dancing, her whole body wriggling with anticipation. Then they reached the edge of the pond.

He hadn't been here in weeks. It was practically dry—an expanse of baked black mud with a scum of yellow ooze at the center, close to the dam. Near shore it was brick-hard and checkered with gaping cracks, but out by the notch in the dam, where he'd cut the race for his turbine, there was a thin layer of water over the mud, ringed with the sulphur-yellow algae. The whole surface of the mud flat was pocked with queer indentations.

Annie ran nimbly out along the natural dyke which dammed the pool, cooing at him to follow her.

Her sleek yellow body was shining as though she'd just oiled it. As he started after her she stopped, just above the reeking pool, and looked back. He shook his fist at her. She waved back, laughing. Then before he could cry out she flung her shining arms above her head and dove headfirst into the mud.

He stood gaping. Ripples spread sluggishly on the surface of the yellow pool. The hole that her body left in the thick mud began to fill. Annie was gone!

Joe Guilder began to tremble. His huge body shivered as if with fever. His lips pursed; his face wrinkled like a crying baby's, and his shoulders sagged. He was alone.

He picked his way gingerly down the face of the dyke. He was afraid of water, and deathly afraid of mud. He'd seen men sucked down, fighting and screaming as the ooze crept over them. He'd watched, terrified and fascinated, as the black muck slid up over their throats, over their straining chins, over their mouths and noses. Sometimes their hair would float for a long time, like matted grass on top of the mud, and big bubbles would be belched up. There were no bubbles where Annie had disappeared.

He moved shoreward along the dam until the crust of dried mud would hold him, and edged out until it began to settle under him, then crept whimpering back to shore. Annie was gone. The hole that had swallowed her was only a dimple in the mud, like all the other dimples that dotted the surface of the pond.

Like all the others! A red bomb burst in front of Joe Guilder's eyes. When he could see again, he found himself on his knees on the mud flats, hammering with the butt of his gun and digging with a pointed stick,

digging into the cracks with his fingers. The crust broke and he pushed his stick down into the warm mud as far as he could reach. He moved it around, and it touched something yielding.

He made a noose of vines and bark and poked it down into the mud, and snared the thing that was there. A pull and it was out. It was a woman—one of the *kru*-girls from his own village. She'd been one of the first to disappear. She was curled in a tight ball, her chin tucked down, her knees drawn up, her arms folded close to her sides with both hands flat over her face. Her hair lay over her like a mantle, and she was covered all over with a hard, transparent amber shell like dried glue. It was like a cocoon of fine, interwoven threads. It was thin; he broke it where it covered her shoulder, and saw a honey-colored fluid oozing from her moist skin, hardening as the air touched it, and repairing the broken shell.

Presently half a dozen of the sleeping *kru* were out of their muddy graves, lying in the Sun at the side of the holes. He shouted, beat them, but they wouldn't stir. They weren't dead, though. He could feel warmth in their inert bodies, and the sluggish beat of their hearts. Annie was like that now. Annie was gone for good!

THE SOUND of voices roused him. They were below, at the base of the dam. His nostrils dilated. White men!

He found his gun, wiped the mud off it and stood at the head of the trail, waiting for them to come round the corner of the power house. In a moment a man stepped into the open and started up the hills, then stopped as he saw Guilder standing

there. Three others appeared behind him—men in the black and silver of the Patrol! And that first man was Hodge—Hodge who should be at the bottom of the river with a rifle bullet in his back, food for the river fishes!

Their guns rapped together. The trader's bullet whined off the rock of the dyke at Joe's feet as his own slug dropped one of the three police. Guilder flopped on his belly on the flat rock wall and began to work back, away from the edge. If he could get into the underbrush he might circle and reach the stockade. Once there, with rifles and plenty of ammunition, he could hold them off for days.

When he thought he was far enough back he scrambled to his feet and raced for the edge of the forest. A shot whined past his head and he dropped flat in the dry rushes and blazed back.

Out on the mud flats something moved. The corner of his eye caught it. Something was crawling out of the slime, climbing up the face of the dam. Something dripping with ooze. It was Annie—Annie come back for him!

He leaped to his feet, shouting. Hodge's first bullet caught him just above the belt. One smashed into

his shoulder; one plowed through his face into the cunning brain behind it. Joe Guilder, king of Venus and its aestivating, half-amphibian *kru*-folk, sagged at the knees and went down.

Hodge's expression was half rueful as he watched the *kru*-girl whom Murdock-Guilder had called Annie. She stood there in the Sun, looking across the empty flats at the place where her white man had been. There was a drift of blue smoke in the air; nothing more. Slowly she turned away, stood for a moment at the dam's edge, and vanished into the mud.

She would forget. The *kru* learned quickly, but they never remembered through the long summer sleep in which, since time began, they had spent the months of dry, baking heat, sealed up in their amber shells under the mud of Venus' dried-up waterways.

Hodge watched the mud seep into the hole which her dive had made. Murdock was clever. He'd worked wonders with the *kru* in the short time he'd had. Maybe, come the rains and winter weather, another man could do as well or better—a man, this time, who knew the kind of tricks Venus played on men who thought they would be kings.

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Vitamin A (Carotene) raises the resistance of mucous membranes of nose and throat to cold infections, when lack of resistance is due to Vitamin A deficiency.



IN TIMES TO COME



Next issue begins L. Ron Hubbard's novel of the end of the war, "Final Blackout." It is based on the assumption that, if a man starts a heavy machine and is subsequently destroyed, a child can't stop the machine. It must go on—and on—and on—till it wears itself out and falls in ruin. Man can't, by the geometry of things (Earth: 8,000 miles diameter. Man: six feet in greatest measure) totally wipe himself off the planet. But with the co-operation of disease he can make a good try.

"Final Blackout" is the story of a lieutenant and his brigade and the rotting remains of Europe—a Europe in which 30,000,000 fighting men and 300,000,000 civilians have died. The result Ron Hubbard pictures is based on accepted—and feared—military knowledge. It is based on historical analogy—the Thirty Years Wars, the Hundred Years Wars—of Europe's reactions.

Perhaps the most interesting single factor Hubbard brings out is the existence of the "unkillables." Men who are immune to disease, to poison gases, whom shells can never find because they have learned every trick of camouflage, of hiding where there is no shelter, men who survive simply because they could not be killed.

H. G. Wells did not write material as grim as this story is—but I feel that even he never wrote anything more powerful than "Final Blackout."

THE EDITOR.

ANALYTICAL LABORATORY:

The January issue closed "Gray Lensman." Therefore, beginning with the February issue, there will again be some question as to what story takes first place.

But though E. E. Smith's great novel took first place easily, there remained a very hot fight for the succeeding positions. The results as of our going to press:

1. Gray Lensman
2. The Smallest God
3. Neutral Vessel
4. Requiem
5. Moon of Delirium

E. E. Smith
Lester del Rey
Harl Vincent
Robert Heinlein
D. L. James

The margins of lead between the places are so narrow, and these results tabulated so early in the month, that there may well be shifting with later letters. So—make up your own Laboratory if you want!

THE EDITOR.

THE EMANCIPATED

By L. Sprague de Camp

Illustrated by R. Isip

Johnny Black is back. Promise enough of a grand yarn, isn't it?

JOHNNY BLACK said: "Fo-wer sco-wer and-a sev-un yee-yers ago-wa, ou-wer fah-vers . . . fah-zerf—"

"The word," said Dr. Ewing, "is 'fathers.' With the voiced dental fricative, like this." The good psychologist made a horrible face as he intoned the "th" of "father," so Johnny could see how his tongue was used. Johnny recoiled a little before he remembered that his instructor had no intention of biting him.

"How?" he asked politely.

Dr. Ewing repeated the consonant whereon so many foreign students of English have come to grief. But the foreigners at least had human dentition, with four large chisel-shaped upper incisors flanked by a pair of chisel-shaped canines. Johnny's upper incisors were six small pegs, and the canines were large conical tusks. No matter what he did with his organs of speech, the resulting sound resembled anything but a human "th" sound.

He had numerous other troubles. For instance, the l's defeated him completely. So Johnny at his best sounded like a Voder with a short circuit. But it was doing pretty well, considering that he had not in his youth established those many chains of lightning reflexes that enable men to rattle off threats, promises, excuses and lies so glibly. And that

his black bear's anatomy had not been designed for speech in the first place. A man learning to type with his toes would be a good analogue to Johnny learning to talk.

This had been going on for months, since a ripple in the affairs of men had brought Johnny and his boss, Ira Methuen, up from the blue Caribbean. Methuen, who had given Johnny his superbearish intelligence by cerebral injection, was now heading Yale's Department of Biology, and Johnny was studying speech at New York University under Ewing.

Johnny was still struggling bearfully with the dental fricatives when Chauncey Malone arrived. Like Ewing, Malone had a lot of white hair. But he was as pale and frail as Ewing was pink and robust. Malone was—grace to Tammy Hall—New York City's commissioner of parks—New York had backslid again.

Johnny said: "Herro, Mr. Marone."

Malone nodded absently at Johnny. He could never be at his best in the same room with five hundred pounds of bear. The fact that the bear spoke to him was, if anything, a little more unnerving.

Ewing said in his hearty, crisp voice: "Hello, Mr. Malone. Well?"

"I've been thinking," said Malone hesitantly. "I haven't quite made up my mind yet."

"Better decide pretty quick. I can keep one animal in my apartment but not two. As it is, I can't

depend on regular milk and newspaper deliveries. The boys throw the bottles and papers in the ash can to avoid meeting Johnny. And my landlord's complaining."

"There's . . . there's nothing in your lease about bears in the apartment, is there?"

"No, but there's a clause about endangering the other tenants. And I want my bathroom repapered. Been hunting for years for wallpaper with octopuses on it, and at last I've found some. But the landlord won't move

while I've got Johnny, to say nothing of Methuen's damned chimpanzee."

"When's the chimp due?" asked Malone. Maybe if he could get Ewing off the subject, he could postpone the moment of having to make up his mind.

"Methuen says he'll be finished with his injections in a few days and will drive McGinty down."

Malone asked Johnny: "What . . . what do you think of the idea of educating McGinty, Mr. Black?"

All the primates—including the mayor—shrieked beautifully. The unchained primates presently hung like clusters of grapes from the topmost rafters and howled.



Johnny said solemnly: "I sink it is a serious mistake."

"Why?"

"I know McGinty. A self-conceited, mean-tempered individuar. Giving him brains wirr not improve his nature."

"Never mind that," snapped Ewing. "Johnny's probably jealous; wants to be the only intelligent animal. Well, how about it?"

"Let me see; I really haven't decided—"

"Oh, for Heaven's sake! It's a simple business proposition. We board Johnny Black and McGinty at the Central Park Zoo; you turn over such of your specimens as we pick for the Methuen treatment. We get specimens; you get publicity. Do you agree, or do I have to approach the Zoölogical Society again?"

"Oh, well, if you insist—we'll do it. But if you damage one of our exhibits—"

"Not much danger. By the way, you'll have to furnish transportation for the specimens. We haven't got a truck. And Johnny's got to be taken to and from his classes up here."

JOHNNY didn't mind the change from Ewing's apartment to the Central Park bear dens. He did threaten to become unco-operatiye if they didn't let him take his mattress along.

His den already contained two female American blacks, Susie and Nokomis, and a male, Ink. They looked at him warily as he toddled into the inclosure with his mattress rolled up and slung over his shoulder. Their smell excited him. They were the first members of his own species whom he had had an opportunity to know personally.

"Herro," he said. "My name is Johnny Brack."

The three bears looked a trifle startled. Of course, he thought, they couldn't understand him, yet. So, with his claws, he cut the strings that held his mattress, unrolled it, and spread himself out on the mattress in a sunny spot. He took the spectacles out of the case around his neck and opened the book he had brought along.

A spectator explained to his small boy: "Sure, that's a grizzly beh. No, behs can't read. He's just trained to do like he was reading. To make people laugh. No, I dunno why the other behs don't read. Sure, they eat people."

Johnny looked up sharply at this canard, and was tempted to contradict it. But, he thought, if he started an argument with the spectators he'd never get time to read his book. So he said nothing.

Johnny found that as soon as he got up to go for a stroll, the other bears made a dive for the mattress. So he spent a good deal of time driving them away from it. He made a point of establishing himself as boss of the cage right at the start. His cage mates, he thought, would be pretty dull company until they received brains. After that they might be useful to him.

JOHNNY HAPPENED to be passing Ewing's office when Methuen arrived with McGinty in tow. Johnny's boss led McGinty, trotting along on his knuckles, by a light steel chain, much more ornamental than useful and not very ornamental. Johnny and Methuen said hello and shook paws and grinned, and Johnny said: "Rook, boss, I can talk awmost as werr as you. Rike zis: 'You may talk o' gin and beer when you're quartered safe out 'ere, and you're sent—'"

"Yes, yes, old man," interrupted

Methuen hastily. "I knew you'd make a marvelous talker once you got started. You remember McGinty, don't you?"

"Sure," said Johnny. He reached a paw toward the chimpanzee, who suddenly jerked the end of the chain out of Methuen's hand, whirled two feet of it around his head, and let fly at Johnny. The steel crossbar on the end stung Johnny's sensitive nose.

"Oof!" cried Johnny. "I show you!"

McGinty was jumping up and down excitedly, grunting, "Keek! Keek!" and showing all his teeth. As Johnny sprang at him he squealed with fear and bolted down the corridor.

Just then the class bell rang. McGinty, terrified, leaped upon the nearest person, who happened to be a girl student, seized her about the neck, and tried to bury his face in her armpit. Now, to have one hundred and fifty pounds of hairy ape suddenly climb your frame is a disconcerting experience. McGinty was merely seeking protection. But the girl could not be expected to know that. She made a noise like a subway-car wheel on a sharp turn and collapsed. By the time Methuen arrived, shouting, McGinty realized he had done wrong somehow and was quite docile.

"Let him alone, Johnny!" cried Methuen. "He doesn't know any better, yet."

Johnny halted. He wouldn't have, for anybody else. "Aw right. But I remember zat bump on ze nose."

Ewing appeared and asked: "Does he behave like that always?"

"No," said Methuen. "At least, not very often. But you can't depend on him. Want to call the whole thing off?"

"No," said Ewing firmly. "I said

I'd teach him, and I will."

After that people saw to it that Johnny and McGinty never met. That was all right with Johnny. He was more interested in his own studies, and in the Central Park bears. Came the day when Ink approached him with a look that Johnny interpreted as signifying an internal struggle; whether physical or mental he couldn't say. Ink stood up, waved a paw at Johnny, and with infinite difficulty managed to groan: "You . . . Dzon-nee!"

Johnny sat up and banged his forepaws together. "Fine! On'y it's Johnny."

"Dzon-ny!" repeated Ink. Another internal crisis shook him, and then, indicating himself, he ground out: "Me . . . Hink!"

"Fine! Fine!" encouraged Johnny.

Ink opened his mouth soundlessly a couple of times, then gasped: "What . . . / what—" He struggled over some question that was no doubt vital to him, but the words would not come. Johnny could sympathize. He remembered his own feeling of futile struggle to put into intelligible form all the thoughts that had swarmed into his mind when he recovered from his own Methuen treatment.

WHEN one of Johnny's fellow students—human—suggested that he come out for football practice, Johnny's insatiable curiosity led him to go along. As it happened, Coach Cohn was feeling irascible. When he finished telling his first string that they ought to wear lace on their uniforms and bring knitting, he roared: "I bet even that bear could do better. Here, Johnny, take right guard in the scrub line for a little scrimmage."

Johnny, still curious, did as he was instructed. When the ball was

snapped, they explained, he was to push through the opposing line and tackle the man with the ball. It was as simple as that.

It was almost too simple. Johnny pushed through the line and tackled the opposing fullback, a youth named Vleck, before Mr. Vleck knew what was happening to him. For that matter he didn't learn what had happened to him until a few minutes later, when he came to. Johnny, meanwhile, turned back to the group surrounding the varsity guard and tackle; between whom he had pushed. Both were lying still and pale, except that the guard, one Martinelli, moaned a bit because of a broken rib. The tackle would be all right when he recovered consciousness.

Cohn shook his head. "Too bad. He'd make a perfect lineman. But nobody would play with us. Too bad. What we wouldn't do to Fordham—"

EWING, for all his good intentions, couldn't keep Johnny and McGinty apart indefinitely. One day Johnny strolled into Ewing's office to report on his studies and found McGinty alone. McGinty was lying on his back on Ewing's desk and smoking four of Ewing's cigarettes at once, one in each hand. He jumped up, scattering sparks and ash, and cried: "Hello, Johnny, how's the old boy?"

Johnny was somewhat taken aback by McGinty's cordiality and linguistic fluency. But he merely said: "Fine. How are you?"

"Oh, I'm fine. I speak pretty well, don't I? Just like a man. Men are a bore, aren't they? Always wanting you to do things at certain times."

"Werr," said Johnny, "you have to do sings at *some* time."

"Me, I like to do things when I

feel like it. They don't understand me. When I want to throw inkwells out the window, I've just got to throw inkwells out the window."

"Have you been srowing inkwerrs out ze window?" asked Johnny, shocked.

"Sure; just the other day."

"Why?"

"You sound just like a man. They're always asking me why I did this or that. I tell them I just felt like it, but that doesn't satisfy them. How should I know why I feel like throwing inkwells? Say!" McGinty suddenly looked sharply at Johnny. "I remember why I threw them. It had to do with you. I'd gotten bored with spelling lessons and wanted to play. And Ewing told me you hadn't approved of giving me the brain treatment. I suppose he wanted to encourage me."

"So you srew ze inkwerrs?"

"So I threw the inkwells. But have you been poisoning Ewing's mind against me?"

"No, not at awr."

"No, huh? Did you say he oughtn't to give me the Methuen treatment?"

"No," Johnny lied stoutly.

But McGinty, a suspicious gleam in his yellow eyes, went on: "I bet you did. I just bet. It's like you. You're jealous because you aren't the only animal with brains any more."

"I never—" said Johnny.

But McGinty continued: "I remember when you jumped on me in the hall. I had to use that chain to protect myself. You bully! You bum!"

"What do you mean, protect—"

"You stuck-up! You animated rug! You flea hotel!" McGinty's voice rose with each epithet until it reached a scream. "I won't stand it! I won't! I won't! I'll fix you! I'll tear you to pieces!" Mc-

Ginty snatched the two inkwells off Ewing's desk. The first went wild. The second was well aimed, but Johnny's lightning reflexes came into play. He dodged and made for McGinty with a squall of rage.

McGinty leaped over Ewing's desk, yelling: "Don't you touch me! I'll tell Ewing! He'll fix you! He'll vivisect you!" He grabbed up two fistfuls of Ewing's papers and threw them futilely at Johnny. Johnny leaped through the storm of paper clear over the desk, fetching up with a crash against a filing cabinet. But McGinty ducked through the knee-hole under the desk and leaped to a chair and thence to the ceiling-light fixture, shrieking: "Help! He's killing me! Help, Dr. Ewing!"

Johnny disengaged himself from the wreck of the filing cabinet just as Ewing and his secretary entered the room. The light fixture came out by the roots just then, and down came McGinty in a shower of plaster.

"Oh, my Lord!" yelled Ewing, surveying his office.

McGinty ran over to him, hugged his waist, and buried his face in Ewing's midriff, crying: "Save me! Don't let him kill me!"

In answer to Ewing's questions, McGinty began pouring out a fanciful account of the preceding events. Johnny tried to break in once or twice. He gave that up, took out Ewing's typewriter, inserted a piece of paper, and with his claws typed:

REPORT
ON THE PECULIAR BEHAVIOR
OF MCGINTY THE CHIMPANZEE
BY JOHNNY BLACK

AFTER THAT, Ewing saw to it that Johnny and McGinty were not allowed to come within a mile of one another when out of their cages. Johnny, watching his bears' minds

grow and burrowing into his own studies, wondered vaguely what McGinty would do next. But, he told himself, it wasn't his business. If McGinty did something horrible to his human mentors, or vice versa, it would probably serve both right.

The months rolled by, though Greater New York still was fascinated by the spectacle of a truck filled with eight bears, ranging from Kobuk, the sixteen-hundred-pound Kodiak, down to Dato, the diminutive Malayan sun bear, making its four-times-weekly trip between the Central Park Zoo and the Bronx.

April came, and April is a special month in a bear's calendar. Theretofore the two female blacks, Susie and Nokomis, had been just a couple of bears to him—as he had been to them. Now things were different.

Ink objected violently. "Rook here!" he squalled. "I do not mind *one* of my girrs. But bot' is no fair."

Johnny, who outweighed Ink by one hundred and fifty pounds, was unimpressed. "I can't he'p it if zey rike me better," he said loftily.

"Is zat so?" Ink bared his teeth and swung; not a playful cuff, such as they were always dealing out, but a slash that sent fur flying and drew blood.

Johnny pitched into Ink. Before much damage had been done, Kobuk came in from the adjoining cage. The keepers, at the bears' request, had left the intercage gates unlocked.

Ink scrambled free and scuttled into a corner, wailing: "No fair! No fair!"

"Don't make no difference," rumbled Kobuk. "Johnny boss. He smart. What boss want he get, understand?"

Ink understood. Thus Johnny became the acknowledged leader of the bear faction. The other bears looked up to him, anyway, since he knew so

much more than they, who could just about talk intelligibly. And if any of them became obstreperous, there was always Kobuk's support. Kobuk fairly idolized Johnny, and what he said went.

THEN, one balmy evening in July, Johnny became aware of activity in the central court, which he could see through the arcade from the feline house to the restaurant. A couple of keepers were shepherding four chimpanzees. Presently a couple of sea lions slithered around from the gate in the fence around their pool. And then came a couple of slinking shapes: the two coyotes. Johnny could hear a murmur of talk, human and animal. Johnny called over one of the keepers.

The man explained: "Sure, the boss tells us to let 'em out in the evenings so they can get together for a couple of hours. We got a big wire fence around the whole grounds, so they can't get away."

"Why can't we get out, too?" asked Johnny.

"I dunno. We ain't got no orders to let you out."

At the next opportunity, Johnny took the zoo director, Pound, to task for discriminating against the bears.

Pound said: "Your friend, Ewing, warned us against letting you and McGinty get near each other."

Johnny protested: "So what? McGinty's ze one who's started trouble each time. So why should we be punished?"

"We-el," said Pound, "I'll speak to Malone about it."

But Malone was not much help. He kept saying: "I don't know. I can't make up my mind about it. If I could only be sure that there wouldn't be any quarrels—"

"Kobuk wirr keep ze bears in order, I guarantee."

Malone went off, muttering about the harshness of a fate that forced him to make decisions. Eventually he returned, announcing that McGinty had said he'd be glad to have the bears join the circle. The elephants were about due to be added, and Malone got them to promise to keep order.

Johnny was surprised but not convinced by McGinty's cordiality. He was sure that it would take very little to start the chimp off on another tantrum. So he and his bears were rather silent spectators at the evening meetings. The other animals told of their experiences, and asked each other innumerable questions about scenes in their pasts which at the time they had lacked the intelligence to understand.

McGinty suggested that they call themselves "the Emancipated."

"Hey, Johnny!" hissed McGinty.

Johnny's keen ear caught the inflections of secrecy and suppressed excitement. "Huh?" he said suspiciously.

"How would you like to do some real exploring this evening?"

"What do you mean?"

"I mean, how about our taking a little trip around the park, all by ourselves?"

"You mean to sneak out?"

"Sure."

"What's ze idea? Ewing wirr take you for a drive anywhere you want, when he has time."

"Oh, to hell with Ewing! Aren't you sick of having men lead you around like an unemancipated puppy dog?"

"Werr," said Johnny. Come to think of it, he was a good deal more restricted in his movements than he had been at the St. Croix Biological Station. That these limitations hadn't galled particularly was due to the fact that you could im-

mobilize Johnny almost indefinitely by giving him a big enough pile of books to read. But still—“No, I sink not. It would cause too much trouble if we were caught.”

“Oh, come on! There’s a place over that way, I hear”—McGinty waved west—“where men meet all night long to denounce things. It’ll be fun.”

Johnny’s curiosity was stirred. The relationships of human beings to their rulers fascinated him, but his information on the subject was entirely secondhand from books. This might be an opportunity to get next to the actual workings of these relationships. “How would you get out?”

McGinty snickered in the twilight. “I stole a set of keys. I won’t tell you how. But we’d be back before anybody missed us.”

“Werr—” Johnny’s prudence struggled valiantly with his curiosity; but as usual his curiosity won. “Aw right.”

Then the keepers came to lock them into their cages.

WHEN it was quite dark, and Johnny’s fellow bears were all asleep, Johnny heard a grunt from in front of his cage, and then the click of the lock. He went out. McGinty, shivering with excitement, unlocked the gate in the big wire fence, and the two set out for Columbus Circle. They avoided the paths and the few people still at large in Central Park.

When they reached Columbus Circle, they could see the black masses of people attending the meetings, sure enough. But the meetings were south of the statue of Christóbal Colón in the center of the Circle; Johnny and McGinty couldn’t get close enough to hear what was going on without coming out in the open.

Johnny, peering nearsightedly over the low stone wall that bounds the Park, voiced his disappointment.

McGinty’s excitement reached a fever pitch. “Say, Johnny, let’s go on over, anyway.”

“What?” exclaimed Johnny. “You know zere would be a riot as soon as we appeared.”

“To hell with that. What’s life without an occasional riot? Scared to take a chance?”

“Yes,” admitted Johnny. “And you’d better be, too.”

“Phooey. You’ve been obeying men so long you think anything they say is right. I’m going, anyway.” And before Johnny could protest any more, McGinty was over the wall and on his way to the crowds.

Speeches were being made by representatives of five minor political parties. The Salvation Army was going full blast next to the American Association for the Advancement of Atheism, and an elderly Englishman was delivering a highly inaccurate lecture on astronomy. The nearest speaker represented the Left Opposition of the Right Wing of the recently purged Left Deviationists of the Communist Party. He was a young man with a small blond beard. If the beard was an attempt to look like Karl Marx, the young man—who answered to the name of Pfusck—had a long way to go.

McGinty trotted up to Pfusck’s crowd. Naturally his presence attracted attention, and in almost no time the Circle’s one cop came over. He saw McGinty, blew his whistle, and fumbled for his pistol.

“What’s the matter?” asked McGinty.

“Gluk,” said the cop, staring at him pop-eyed.

“I said, what’s the matter?”

“Oh,” said the cop. “You’re one of these here talking animals, huh?”

Thought I was hearing things foist. Whatcha doing here?"

"Just sightseeing," said McGinty.

"Oh, just sightseeing, huh? Well, you don't do no more 'just sightseeing.'"

"I'm not hurting anybody," said McGinty. "Please, can't I just listen?"

The cop thought. Getting the chimpanzee back to wherever he belonged would present a problem. "Well, you stay where I can keep an eye on you, and no monkey business."

McGinty looked insulted. "I am not a monkey. I'm an ape."

"It's all the same to me. Any monkey business, and I'll run you in."

COMRADE PFUSCH was at a hopeless disadvantage as long as McGinty was competing for the attention of his audience. They began crowding around McGinty, asking questions like: "Say, buddy, how does it feel to be an ape?"

McGinty called up to Pfusch: "Go on, I'm listening."

Pfusch tried: "These people, who call themselves Marxists, are intellectually bankrupt, as I explained. A real Marxist organization welcomes constructive criticism. . . . Say, officer, can'tcha take that ape away? He's busting up my meeting."

"Huh?" said the cop, feeling suddenly more friendly toward McGinty. "Why should I? He ain't doing nothing."

"I demand that you take him away. I got a right to free speech, haven't I?"

"Go ahead and speech. I ain't stopping you."

"See, comrades? That shows you how much your so-called constitutional guarantees are worth. Well, as I was saying, where were these

people in 1959? Recommending revolution at a time when a dialectical analysis showed that a revolutionary situation did not exist. Treachery to the working class, obviously. Then in 1964, when these traitors, these lackeys of the bourgeoisie— Say, officer, you gotta take the monk away."

"What do you mean, monk?" snapped McGinty.

"I mean you," said Pfusch. "Gwan, chase yaself, willya?"

McGinty advanced menacingly. "I don't let anybody call me a monkey."

"Gwan, this is a meeting for workers, not monkeys."

McGinty mounted the stand, bared his fangs, and reached for Pfusch.

Pfusch tumbled off the stand and clutched the cop's sleeve. "Help! He's threatening me!"

"He don't let nobody call him a monkey," said the cop impassively.

"But he's got my stand! He can't do that! I got a right—"

"Ga wan before I run you in."

The audience, preferring drama to dialectic, cheered McGinty. McGinty hesitated a bit, then launched into a little speechifying of his own: "Equal rights for chimpanzees!" he shrilled, standing on one hand and gesturing with the other three. "Smash the tyranny of men over the animal world! If zoo keepers can dictate to chimpanzees, why not chimpanzees dictating to keepers? Say, that's an idea. Your own leaders are in-intel-intellectually bankrupt. Why not try us, the chimpanzees? Only a stranger can be impartial, as Bernard Shaw put it—" There was a lot more, much of it irrelevant or incoherent. But an audience of thousands was still approving when a department-of-parks truck

full of keepers arrived to take McGinty into custody.

"There they are!" he screamed, pointing. "The villains! The tyrants! Tear them limb from limb!"

The audience laughed and opened a lane for the keepers. McGinty, seeing that his appeal was not being taken seriously, made a half-hearted effort to escape. But the crowd could not have opened to let him get away, even had it wished. When keepers and cops appeared on all sides of him, with nets, ropes, hypodermics, buckets of chloroform, and guns, he submitted tamely enough. All the way back to the zoo he wept and shivered with despondent apprehension.

When the keepers, having stowed McGinty, made a checkup of all the cages, Johnny was sound asleep in his den. He had pulled foot for home the minute the truck appeared. When Pound questioned McGinty about his escape next day, McGinty claimed that Johnny had not only accompanied him, but had suggested the escapade in the first place. Johnny denied having left his cage at all. Since nobody had seen him, it was his word against McGinty's. Pound, knowing McGinty's unreliability, believed Johnny and ordered McGinty confined to his cage for a month. By the time the month was up, the autumn was too far advanced for the apes to be allowed out in the open anyway. The sea lions were away most of the time on a theatrical engagement; the elephants disliked the cold; so the meetings of the Emancipated petered out.

With a mind as omnivorous as his digestive system, Johnny was having the time of his life. The New York University authorities let him attend any classes he wished. And among his bears he felt, for the first

time in his life, that he belonged. Kobuk appointed himself Johnny's bodyguard, and nobody argued with Kobuk. When a professor of history objected to Johnny's presence in his class because it distracted his human students, Kobuk stood up and coughed. He looked ten feet tall. Johnny continued to attend the class.

Came spring, and when the weather was warm enough the Emancipated recommenced their evening meetings. Johnny expected McGinty to start a row about their respective parts in the Columbus Circle incident. But the mercurial McGinty was this time in a silent and saturnine mood, sitting with his chin—or the place where his chin would have been if he had had one—on his fist. He said he had spent a good deal of the winter reading Sorel and Pareto. Johnny had heard of these direct-actionist philosophers, if he hadn't read them himself. He guessed that they had proved a heavy load for the chimpanzee's brilliant but immature mind.

The cats had all received the Methuen treatment by now. They loudly demanded the right to attend the meetings. Pound referred their demand to Malone, who went around saying, "Oh dear me." When Malone asked the Emancipated what they thought of the idea, there was a unanimous "No!" The elephants, for anatomical reasons, had never been able to learn to talk. But Rosebud pulled the oversized pencil out of the band around her foreleg and wrote on the pavement: "I don't like cats, especially big ones with stripes." She underlined "like" twice.

So the cats stayed in their cages, having to content themselves with occasional plaintive roars of "We want to join you!" during the sessions.

The sea lions were back. Being born extraverts, they enjoyed their work. But their demands for personal salaries, equal billing with the Rockettes, and one spotlight per sea lion had ended the experiment.

When the sea lions had finished barking their tale of woe, McGinty swung himself to the top of the iron fence around the sea-lion pool. He said: "All this proves what I've been saying. You'll never get your rights from man by talk."

"What zen?" rumbled Behring, the male polar bear.

"Force! How did we get here in the first place? Force! How do they keep us here? Force! What settles every question between organisms in the long run? Force! I've read—"

"What is an organism?" asked Kobuk.

"Never mind. What are we? Nothing but a lot of playthings for men! What rights have we? None! What can we do if they decide to starve us and eat us? Nothing!"

The outburst rather staggered McGinty's audience. The elephants shuffled uneasily.

Johnny said: "Some troof in zat. But ze men have *awr* ze force. Zey treat us pretty werr now. But you try using force; see what happens to you."

McGinty snapped: "Are you so afraid of dying you won't risk anything for liberty?"

"Zat's right," said Johnny.

"You'll have to die some day."

"I know. Don't want to die any sooner zan I have to, zough."

"Coward! I always knew you were on their side. I haven't forgotten your running out on me last fall. If we're going to get anywhere, it must be by united action."

Johnny's thick hide shed McGinty's epithets as easily as it did water. But he did think that obvi-

ous misapprehensions should be corrected. "I just meant it's no use getting in trouble when we can't do anything. I know somesing about—"

"That's enough!" shouted McGinty. "Coward! Traitor! Lackey of the bour— I mean the human race! None of us want to hear you, do we?"

And the other four chimpanzees, who had worked themselves into an almost equal state of excitement, cried: "No! Get out!"

Kobuk stood up and stretched. "Sink you can srow us out? Ret's see you!"

McGinty yelled: "No rough stuff! If there's a fight it'll be the end of everybody's privileges!"

The elephants rolled forward a step or two. The bears stood up in a bunch, looking at Johnny for instructions.

Johnny said: "He's right; no rough stuff. Zat doesn't mean we're going to reave."

So the primate and bear factions settled into a state of inactive but watchful hostility. The remaining animals oscillated between the two groups.

CAME Independence Day. Malone came around and told the Emancipated that Mayor Coffey was going to speak to them at 7:00 p. m., and would they please behave themselves particularly well on that occasion. He didn't say that he had tried to dissuade the mayor from what he, being a timid soul, considered a rash act. But in the mayor's mind the publicity that would accrue from a speech made under these circumstances outweighed all other considerations.

The mayor arrived, only half an hour late, in a swirl of motorcycle cops. He had already made nine speeches that day, but you would

never have known it. Mayor Coffey was a huge bulbous man with little red blood vessels showing through the skin of his nose. He had a voice of thunder and, apparently, a larynx of tungsten steel.

McGinty had suddenly turned cordial. He insisted on shaking paws with all the bears, and to show his trust in them—he said—he asked to be allowed to sit among them.

Malone got up and introduced the mayor. There may have been worse speakers than Chauncey Malone, but if so history does not record their names. So Coffey's full-lunged bel-low was something of a relief to everybody. He roared: "And so, my animal friends, in consideration of and in recognition of and as a reward for your exemplary behavior, your admirable deportment, your splendid conduct, I am pleased, happy, glad to announce on this historic occasion, this sacred date, this memorable anniversary, that we are going to furnish you with a splendid new structure, a beautiful new assembly building, a magnificent new social hall—"

Dato, the sun bear, whispered to Johnny: "Does he mean one buird-ing or sree?"

"Shh!" hissed Johnny.

"—for which the ground will be broken three weeks—twenty-one days—from today. I shall be glad, happy, overjoyed to meet you all here again on that auspicious occasion, that felicitous celebration, that jolly reunion, that—"

"What do zose big words mean?" whispered Dato.

McGinty had been sitting among the bears, quietly smoking a cigarette. Behring, next to him, had gone to sleep. Nobody had seen McGinty, with his left rear hand, slowly insinuate a large wooden match between two of Behring's

toes. Nor did they see him lower his cigarette to touch the protruding match head.

But they all heard Behring's sudden bawl, and saw him leap straight up from his seat. Before he came down to earth again, McGinty had scuttled out from among the bears. The mayor stopped in the middle of a metaphor as McGinty dashed past him. After the chimpanzee came one thousand two hundred pounds of polar bear, knocking other animals out of his way and snarling like a thunderstorm.

Everybody screamed and ran. Having their backs turned, they did not see Johnny leap on Behring's back and hold on for dear life while the polar, mad with fury, reared and rolled and foamed. Then the keepers came with their nets. In the tussle Johnny received a couple of nasty gashes from Behring's claws and teeth. But eventually Behring was knocked out with chloroform and returned to his cage. Mayor Coffey went home to nurse his nerves, and to issue an order to Malone that no bears were to be let out of their cages under any circumstances.

Behring, when he came to, tried to explain what had happened to anybody who would listen. They listened, but they didn't let bears out any more. Ewing had to bring all their schoolbooks down from the Bronx so they could continue their studies. Some did; some were too lazy to do so without human supervision. Johnny was irked; he had enjoyed a good deal of freedom, and being cooped up twenty-four hours a day didn't set well with a bear who held a Master's degree—honorary—from Columbia University.

One evening McGinty came over to taunt him. The chimpanzee said: "Hee-hee! The great Johnny Black



"Go away!" shrieked McGinty. "You're unfair!" Johnny lifted his lip slightly, settled his legs more firmly and growled. McGinty bounced up to the chandelier and screamed for help.

locked up like an unemancipated brute! That's funny! If you'd had sense you'd have stuck with me, instead of opposing my plans. Now I've got you where you can't interfere."

"What's zat?" asked Johnny

sharply. But McGinty merely hopped up and down and hurled insults. Johnny yawned ostentatiously and went back to his books. But he wondered what McGinty had in mind.

The next day he sent one of the

keepers to fetch Pound. He told him a few things about McGinty, and said: "If I were you, I wouldn't ret him out for zis ground-breaking ceremony. He has somesing up his sreeve."

Pound said, "I'll ask Malone." Which he did. But Malone was afraid to bring the matter up with the mayor, who had developed a certain touchiness on the subject of bears.

JULY 25th was hot and sticky. Mayor Coffey suffered particularly. But the chance to make a speech was too tempting for him to forgo the ceremony.

Johnny found that the scene of the occasion was visible from the top of the rocks in his den. So he sat there, reading with elaborate unconcern, while people and fauna gathered on the spot.

The sun went out. Johnny looked over his shoulder; a fleet of huge dim thunderheads was drifting over the skyscraper apartments on Central Park South. Johnny prudently put his book in his den and returned to his post. The only animals present on this occasion were the five chimpanzees, the orangutan, the gibbon, the chacma baboon, the two coyotes, and the four sea lions. Though the elephants had been well-behaved enough, Coffey didn't trust anything of their size.

Johnny could hear Coffey's bull voice, though he couldn't make out the words at that distance. Then raindrops began to spatter on the rocks around him. They got on the lenses of his spectacles. He irritably put the spectacles away. That would happen just when he was sure something interesting was going to happen!

He couldn't see clearly at that distance without his glasses, especially

through a curtain of rain. But he could make out moving blobs that were people leaving the ceremony and running for shelter. Coffey's voice rolled on. It would take more than a thundershower to stop Coffey in a speech.

Then the speech was cut off short. Johnny could see a maddeningly dim blur of motion in the crowd—or what little was left of it. A blob detached itself from the rest and moved swiftly toward the monkey house. There was a chorus of shouts, muffled by the rain. The moving blob passed out of sight. The lions and tigers, between Johnny and the monkey house, woke into a chorus of excited roars.

Johnny fretted with unsatisfied curiosity. He began pacing the length of his inclosure, like any unemancipated bear. The other bears threw futile questions from cage to cage. Men ran about outside, calling to each other. But nobody said a word to the bears.

Hours passed, until the roars and squeals from the various houses reminded the keepers that their charges' meals were long overdue. When the black bears were brought theirs, Johnny asked the keeper what was up.

"They kidnaped the mayor!" explained the keeper.

"Who did?"

"The apes! They jumped on him while he was makin' his speech, and dragged him into the monkey house. The cops couldn't shoot for fear of hittin' him. Now they're holdin' him for ransom. Every time we try to get near, they pinch him to make him yell. Say they'll kill him if we try to rescue him."

"What do zey want?"

"They say they want the department of sanitation's mansion turned over to them and, oh, a lot of things.

"They ain't gonna let him go, either."

"What are you going to do?"

"Good Heaven!" cried the keeper. "How do I know? It serves 'em right," he went on, not explaining whom he meant by "them." "These educated animals are against nature."

THAT was all the information that Johnny had to work on that night. He thought and thought. He, personally, didn't care the least about Mayor Coffey. If the chimpanzees and their fellow conspirators wanted to take Coffey apart, joint by joint, that was their business. If the officials of the city of New York couldn't think of a method of thwarting the apes' felonious designs, that was their hard luck.

A yelp from the monkey house indicated that the swarms of policemen who infested the zoo had made another attempt to sneak up, and had been detected.

But, Johnny's thought rambled on, he was, through no fault of his own, one of the Emancipated. Whatever one of them did would reflect to some extent on all. If the apes murdered Coffey, the other members of that domineering and vindictive species, Man, might very easily wipe out all the recipients of the Methuen treatment to prevent future revolts. And that would include him, for all Ewing or Methuen could do.

He could see McGinty's point of view, much as he disliked the temperamental chimp personally. If the apes could get away with their daring scheme, he wouldn't be without some slight sympathy for them. But he knew that in the long run they would fail. Men were too numerous and clever and powerful. Besides, self-interest demanded that, if he had an opportunity of thwarting McGinty, he should take it. It would

not only save his own hide, but that of the other emancipated bears, whom he liked. And, of course, he would get credit for one more brilliant coup. That wouldn't be hard to take.

But how to thwart McGinty? That was the point. It would be easy simply to storm the monkey house, but that would result in Coffey's death. Perhaps he could gain admittance on the pretext that he was going to join the apes. But it would still be doubtful whether he could release Coffey and get him out unharmed. He could kill a single ape without much trouble, but only one at a time.

Next morning, when a keeper came by, Johnny asked him: "Wirr you terephone to Professor Ewing at New York University, prease?" The keeper thought a good deal of Johnny, and did so.

When Ewing came down that afternoon, Johnny asked him to get several good books on apes.

"What are you up to now, Johnny?" asked Ewing.

"I want to see if somesing can't be don't about Mr. Coffey."

"Have you a plan for rescuing him?"

"No, but maybe I get one."

"But how would you get them to let you out of here?"

"Zat wirr be your job."

"Me? What could I do?"

"Get zem to ret me out when ze time comes."

And that was all Ewing could get out of him. Ewing himself was worried; a slaughter of the Emancipated would be a serious blow to his own researches. So he returned in the evening with a bucket of coffee and an armful of books. He made some feeble joke about needing coffee to rescue Coffey, and departed, leaving

Johnny sprawled out on a rock with his own personal reading lamp shining over his shoulder.

Next day the siege continued. One of the apes called out: "He's getting weak. You better send in some food."

But when a cop appeared with a lunch box, the apes chattered excitedly and refused to let the cop approach. They yelled: "Have to send it in by one of the animals. We don't trust you."

So there was another long delay. The female coyote finally agreed to carry the lunch box in. She reappeared in a great hurry, explaining that, once she was inside, the apes accused her of having run out on them after agreeing to join the plot, and, working themselves into rages, had tried to grab her. When she escaped, the apes had nothing to do but take their anger out on poor Coffey, who was pinched and pommelled unmercifully. Those outside could hear his yells, sadly diminished in volume.

Johnny, meanwhile, was deep in Yerkes' "The Great Apes," the chapter on "Affective Behavior of Chimpanzee: Behavioral Patterns of Emotion." He had thought of various expedients: taking a time bomb into the monkey house—no, that would have the same effect on Coffey and

—what was more important—on himself. The same objection applied to tear gas. The devil, there must be some agent that would discriminate between apes on one hand and bears and mayors on the other. Drugs? Anæsthetics? Poisons? Hypnotism? Threats? Promises? Nope.

Johnny resumed his reading, while outside the grotesque deadlock continued.

Then he had it. "Smitty!" he bawled. "Get Professor Ewing! Get Mr. Marone! Get Mr. Pound!"

POUND called to the monkey house: "Hey, apes! The smaller animals are all afraid to take your food in. O. K. if we send Johnny Black?"

There was a pause, and then the answer came back: "O. K."

Johnny plodded across the flagstones with a suitcase in his jaws. The suitcase supposedly contained fruit for the apes and more solid food for their prisoner.


The door swung open, just wide enough for him to squeeze in. It was obvious to him that they intended to let him out in their own good time. But he was confident of his ability to handle them all in a rough-and-tumble fight, if it came to that.

The little monkeys skittered un-


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comprehendingly around their cages. At the far end Coffey's huge form was tied to a cage bar by a steel chain around his leg. McGinty had no doubt stolen the chain and concealed it sometime before. Johnny couldn't help a grudging admiration for McGinty. Right behind Coffey crouched the recently emancipated chacma baboon, with his forepaws around Coffey's neck. Evidently his duty was to rip Coffey's throat out with his great teeth if anything went awry. Two of the chimpanzees, the orang, and the gibbon were at the windows. The other three chimps, including McGinty, squatted on the floor.

"Well, Johnny," said McGinty, "don't you wish you'd joined us now? This is real fun."

"Yes," said Johnny. "Can't I join you now?"

"No. Too late. I don't trust a traitor like you."

"Is zat so?" Johnny put the suitcase down and sat on it. "Zen I guess you don't want any food."

"You've got to turn over that food, or we'll kill the mayor."

"Go ahead," said Johnny. "I never riked ze big fat srob, anyhow."

"What if we tell the people you asked to join us?"

"Zey won't berieve you."

"But the mayor heard you say so."

"If he's dead, he won't terr zem."

At this point the mayor wailed: "For Heaven's sake, Johnny, leave that grub here and go. It gives me the creeps, the way you talk about the advantages and disadvantages and virtues and risks of killing me."

McGinty said: "Suppose we take the suitcase away from you."

"Try it," answered Johnny, looking thoughtfully at his claws.

The apes retired to the far corner and muttered. Then they came back. McGinty inquired: "Do you

really want to join us? Honest Injun, cross your heart?"

"I said so, didn't I?"

"And you'll forget all those arguments we've had?"

"Sure."

"All right." McGinty extended a hand. Johnny shook casually. He picked up the suitcase in his teeth and padded over to near the mayor. If he was excited, which he was, he didn't show it. The next few seconds would tell.

He pushed the snaps on the suitcase with his claws. Then he picked it up in his forepaws and inverted it. The top fell open.

Out onto the concrete floor poured two dozen live garter snakes.

Eight emancipated primates were watching. From eight primate throats there rose a simultaneous shriek of such bloodcurdling horror that even the cops outside jumped. And, like a flash, eight emancipated primates rose straight up, as if on invisible wings, to the very top of the cages, where the bars entered the ceiling. There the apes clustered in groups of two and three, hugging each other, trying to bury their heads in the center of the cluster, and screaming at the top of their lungs.

The garter snakes rustled on the floor. They tried to crawl, but could make almost no headway on the smooth surface. They went through all the motions, but stayed in the same place.

Johnny looked at the mayor. It was unfortunate that Coffey should suffer from snake phobia almost as violently as apes do. Had he not been chained, he might very well have hoisted his two hundred and fifty pounds to the tops of the bars as his captors had done. Being unable to do so, he had fainted.

Johnny looked at the chain. It had probably served to lead a ter-

rier or Peke at sometime. But a chain that will restrain a dog may not be strong enough for a bear. Johnny hooked his claws into the links and heaved. *Snap* went the chain.

Presently Johnny appeared at the door of the monkey house with Coffey draped over his shoulder. To Pound he said: "He wirr be aw right. He doesn't rike snakes. Have ze keepers gazzer up zose snakes, prease. Ewing promised zem to me for supper."

"But," cried Pound and Malone together, "what about the apes?"

"Oh, zey are zere. You wirr have to scrape zem off ze ceiling."

"You've done it again, Johnny!" exclaimed Ira Methuen. "If you keep on like this, I shan't have to do any more work. I can live on your publicity."

Johnny asked: "What wirr be done wiss ze Emancipated?"

"They won't be killed. But they'll be scattered. The zoo has arranged with other zoos to trade them for other animals, so there won't be more than one in any one place. Too dangerous to let them be together, they say. But, of course, you can have just about anything you want."

Johnny thought. Then he said: "What I want most is to go back

wiss you. I want to be wiss somebody who reary understands bears."

Methuen gulped a little. "Well, uh, to tell the truth, Johnny, I was beginning to miss you pretty badly myself. How'd you like to drive up to New Haven with me tonight?"

"Fine. But before I go, wirr you prease take me around behind ze monkey house?"

"Why?"

"Ah, zere is a sound I have been practicing. It is a very difficut sound for a bear. But I sink I have it down pat."

"All right."

So Methuen led Johnny, on an ornamental but entirely useless chain, around to the back of the monkey house.

Johnny stood up on his hind legs and called: "McGinty!"

McGinty's face appeared at the window, scowling through the bars. "What do you want, you traitor, you liar, you fiend, you villainous flea-bitten scoundrel?"

For answer, Johnny protruded his lips, protruded his tongue between them, and blew. The unseemly sound that issued would be described by a phonetician as a voiceless labio-lingual roll.

Then Johnny followed his god, Methuen, to the latter's car. He was content.

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Illustrated by E. Hatcher

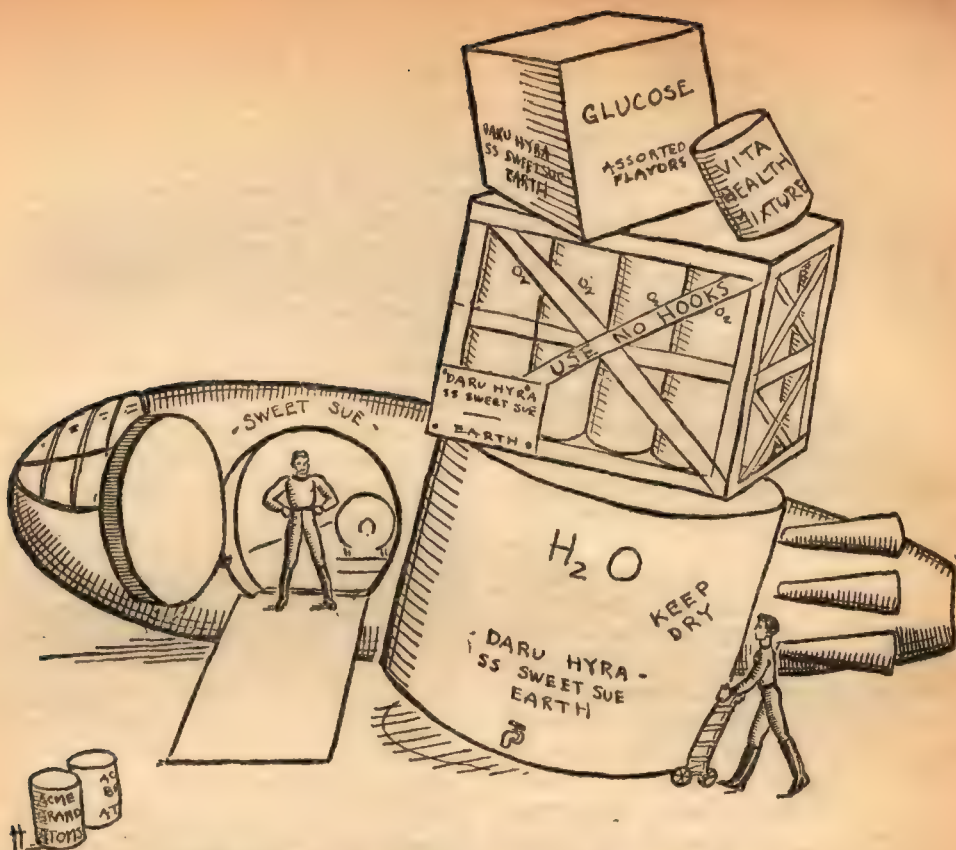
A FEW years ago, when atomic power seemed only an idle dream, one of the common suggestions for space rocket fuel was liquid hydrogen and oxygen, delivered to jets in the rocket tubes and there burned to water. But now atomic power seems right around the corner, and we hear less and less about hydrogen and oxygen, in spite of the fact that there are going to be a lot of machines in these new spaceships that can't use atomic power. They're the most complicated and almost the oldest prime movers ever developed, these machines, extremely delicate and fragile, unstandardized, and irreplaceable—and they can only use the energy from the combination of hydrogen and oxygen. They're human beings!

In a strict engineering sense, a human being is but a very complex machine capable of turning a particular form of energy into work, which obeys the laws of thermodynamics like any other machine; so long as it's alive, it's doing work and liberating heat, and you can't turn it off or shut it down temporarily. In fact, one might define death as the point at which the machine ceases to use energy; that particular form of death called "starvation,"

when the machine runs out of fuel, is not a pleasant one, and so here on Earth or in interstellar space, the human fuel problem is first and foremost.

One of the commonest delusions of the science-fiction writer is the one about "condensed food" rations; again and again, we read of our human hero gulping his daily food in three small tablets, and promptly feeling fit and fresh as a fiddle again. It's not the idea of synthetic foods that's wrong—it's the size of the ration. What the human machine wants out of that fuel is energy, and you can't get enough energy of the right kind in such small packages. The human machine just doesn't work that way, and we know just enough about how it does work to be certain that we aren't going to be making any changes for a long, long time.

It is possible that we might manage to construct a new race of thinking machines capable of assimilating atomic or electrical energy within a few thousand years, but would they be human machines? I have a hunch we'd better just forget it and let evolution take its tedious course in that respect—we'll be lucky if we breed out the imbeciles and idiots in



"Daru Hyra quickly loaded two years' supplies of food and oxygen for himself and his companion into his trim little spaceship—"

the next couple of hundred years—that would be a real achievement.

In the meantime, we might stop worrying about adapting the machine to new energy sources, and get down to facts with the problems involved in developing energy sources of the proper sort for the machine as it is—in other words, fuel. Today the dietitians call it food, and they talk about carbohydrate, protein, fat, mineral, and vitamin requirements—will we call it fuel and talk in these terms tomorrow? From an esthetic standpoint, of course, one dislikes the thought of no more nice juicy steaks or frivolous pasty; eat-

ing is a pleasure to many, and why change it? There just isn't any reason, as long as one remains on Earth itself.

We know quite accurately, the necessities for nutritional sufficiency, and at present, the basic problem is not further knowledge in this direction but finding some means of enabling more than just one quarter the people of Earth to enjoy that sufficiency, and that is a strictly economic problem which we can't discuss here. But what we can do, is examine closely what are the basic needs of human machines: man may not long be Earth-bound, and once

he leaves the natural sources of food existing here, he is confronted with three alternatives: finding similar fuel on other planets, taking it with him, or producing it himself.

LET'S ATTACK the problem from the engineering standpoint. First, what are the ultimate, basic requirements, regardless of sources or economics? Well, as with any machine, the energy input is directly related to the work output desired; the human machine is about 20% efficient in this respect—about the same as a gasoline motor—so it's easy enough to calculate what you want the machine to do and supply the necessary. The daily output of the average person in a sedentary occupation is about one horsepower hour, with a consequent requirement of some 3,000,000 calories of fuel. That may be only three kilowatt hours, in electrical energy, but we can't use electricity; we said that the human machine used only the energy from the combination of hydrogen and oxygen, but that doesn't mean burning them up in a blowtorch! This machine gets the same amount of energy, but by a much neater and more efficient process, in which the hydrogen is split off from particular chemical compounds, known as metabolites, and passed along through a series of intermediate compounds until it ends up as water. The total over-all energy of our blowtorch is thus split up in little hunks, a little at each step, for convenient use.

Now how this energy gets used, as in moving an arm, is pretty much of a riddle. We do know that throughout this whole series of metabolic processes which liberate energy, certain particular compounds are formed, in which the energy is stored, and these com-

pounds, such as adenosine triphosphate and creatine phosphate, actually break down themselves as a muscle contracts. But how the energy liberated in the metabolic breakdown gets transferred to the synthetic reaction, and especially how energy liberated in the subsequent breakdown is transformed into the purely physical work of muscle contraction are unsolved problems. Somebody'll get the Nobel Prize for figuring them out, some day.

And for our purposes we only need the indisputable fact that we can't short-circuit this final process anywhere. The human machine is entirely too complex, and you can't just dump something like adenosine triphosphate into it; you have to put it in all the right places in the proper combination with all the other substances necessary. And if you try taking doses of these various and sundry substances by injection or by mouth, you'll promptly go into very pretty convulsions. The point here is that only the machine itself is capable of manufacturing these necessary compounds in the right places at the right time, and it won't transport anything but the proper raw materials to the manufacturing establishment.

So, we can't put in the final synthetic products. But we can supply the exact proper raw materials, short-circuiting some of the preliminaries such as digestion and absorption. The interrelations of these two latter processes with the general metabolism are so complex that this may be, at present, pretty hazardous business for humans, but there are some fifteen or twenty generations of mice and rats which have been fed on a diet consisting almost exclusively of pure chemical compounds—and they're perfectly

healthy and normal. Let's see what these proper raw materials are.

FIRST, to take care of the energy requirement, we will supply pure glucose. This could be—as it is in hospital cases when the patient can't take food by mouth—supplied directly to the blood stream, and in fact, all of the various raw materials may be put into the circulatory system and the stomach missed completely. But, intravenous injection requires considerable skill and aseptic conditions; continuous puncturing of the veins is bad; and finally, in so supplying materials extreme care must be taken not to unduly dilute part of the blood stream or the heart will stop. And, of course, if the stomach doesn't have anything at all inside it, it might get annoyed, and that would be unfortunate. It is best, then, to take our materials orally.

Our energy requirement was 3,000,000 calories per day, and this will be some 800 grams of glucose—almost two pounds. And that's the little figure that rather spoils the fiction writer's ideas of just taking a couple of little pills a day, and it is quite inescapable. The energy necessary to keep the human machine running, even at a low work output, is 3,000,000 calories per day, and the best form of energy supply is glucose and it amounts to two pounds. And two pounds of glucose is more than a pint, and nobody is going to compress that pint of glucose into three little pills, if for no other reason than the simple fact that if it did get compressed much it wouldn't be glucose any more. The biggest pill one can conveniently swallow is about 1 gram—so it's closer to eight hundred pills than three, if we wanted to make pills of it!

What else does our machine need?

Well, like any other machine, there are minor replacements and repairs which are necessary from time to time. But these human machines are pretty neat gadgets, because they do their own repair work; again, all they need is the proper raw materials, and they'll manufacture the necessary parts in exactly the right places. But again, they have to have exactly the right raw materials, and in this case the materials are amino acids. There are some twenty-three amino acids which are known to occur in living organisms, and some ten of these are classified as "indispensable"; that is, they contain particular molecular structures which the animal organism cannot synthesize, such as the indole grouping in tryptophane, et cetera. The quantity of such synthetic materials required by the average human machine amounts to about 50 grams per day, which is only about an ounce and a half, but it's still a pretty big pill, and it, too, should be supplied at fairly regular intervals. Note that here, as in the case of the energy requirement, we can substitute pure chemical compounds for the essential elements normally derived from the digestive breakdown of natural material.

WHEN it comes to the nutrition expert's "fat requirement," we are in a slightly more difficult position. Fats are, in the most general sense, esters, a combination of fatty acids and glycerol or cholesterol. Glycerol—glycerin—is promptly metabolized to glucose in the body, so we don't need that. And the vast majority of the fatty acids are likewise broken down and converted to various carbohydrates such as glucose, so we don't need them. The cholesterol is apparently required, as are some of the long chain un-

saturated fatty acids. At present, there is little data on human requirements, but a considerable amount of work has been done on rats and mice, and we can at least suggest the ultimate answer. Certainly not more than about 10 grams or so of the proper substances will be necessary, and they will include cholesterol, and linoleic and oleic acids, which the human machine apparently can't synthesize from something else.

If one wanted to go on a synthetic diet today, he'd probably have to get about 60 grams of assorted fats, to be on the safe side; it is only a minor requirement in terms of the total amount necessary, but it is very essential, as Germany is finding out in her attempts at synthetic fat substitutes. They have been attempting to cut down the amount of fat and replace it with substitutes—any substitute that is cheap and available, without regard for the actual requirements involved.

The mineral and vitamin requirements of the human machine may be classed, in our bioengineering terms, as "intermediates" which are necessary for the various synthetic processes the body carries out; the total quantity required is extremely small. Nobody really knows what the minimum potassium, sodium and chlorine requirements are, simply because it is so difficult to get the usual natural diets free of these elements, but it's certain our synthetic fuel will have to contain somewhere around 5 grams of them. Calcium and phosphorus will total around 2 grams, while all the rest of the elements, including iron, magnesium, copper, iodine, zinc, and manganese will not amount to another gram, making the total amount of minerals somewhere around 8 grams.

There's probably nothing very ex-

citing about these minerals, in one sense, because we don't know any too much about them; the main problem will be getting exactly the right amounts, because too much, as well as too little, would be disastrous. As yet we are not sure of the exact amounts of the mineral constituents, but in some cases we know that the ratios of the quantities of some of these elements to each other is extremely important, as in the case of the calcium-phosphorus ratio.

OF recent years, considerable attention has been attracted to vitamins as essential factors in nutrition. Biochemically speaking, they are no more important for the normal functioning of the human machine than a great many more complicated organic compounds of various sorts, except for the fact that these compounds are ones that the machine itself can't synthesize. Consequently, they must be supplied from external sources, and while the isolation and concentration of these substances from natural sources has been the common way of obtaining them until the last few years, we can now produce every one in the laboratory—in a couple of cases, so very cheaply as to upset our present-day economy rather badly.

Take vitamin C for example. The best natural source is the citrus fruits; in fact, this is one of the sound reasons for encouraging a high consumption of oranges and lemons. But today one can buy pure synthetic vitamin C at \$2.75 per ounce—less than the actual cost of just raising sufficient lemons to supply the same amount! That, from a bioengineering standpoint, spells the ultimate doom of the citrus industry.

One can confidently predict today

that all of the important vitamins have been discovered, isolated and identified, and it won't be many years until the remainder are cleaned up, simply because of the enormous amount of work that is being done on the problem. It is an interesting fact that this work of isolation and identification is not being done solely by "pure" scientists, as it was in the past—there's money in it now, and every large industrial research organization in the field is having more or less of a crack at it. Why? Because when the final chemical structure of a vitamin is written down, there is a mad scramble to develop a cheap, commercial synthesis, and the winner is the organization that develops and patents the cheapest method of manufacture.

Take the case of vitamin B₆, for example. It was known that there were several other individual chemical compounds of the "B complex," but until a biological assay method was developed nothing much could be done. Finally, early in 1938, it was reported that the rats which had been fed only the known members of the B complex developed a peculiar dermatitis. And the rush began; it took just six months to isolate, identify, and develop a fairly cheap method of synthesis for the substance whose lack was responsible for the dermatitis—there was a gap of twenty-three years from the first known assay method for B₁ to commercial synthesis.

THE AMOUNTS of various vitamins necessary have been pretty well worked out; the normal high quality American diets of the moderately well-to-do classes, probably contain adequate amounts of all of them, with the possible exception of B₁. It is extremely difficult to get enough

of this particular one, especially as it has been carefully removed from white flour by the modern milling process, and it is troublesome in another way—fully 60% of the intake is destroyed and/or excreted within twenty-four hours, and there is no storage at all of the substance, so that it must be supplied at short intervals. But the total sum of all the vitamins is 85 milligrams, and here, at last, we are down to pills.

While fuel, replacements, and synthetic intermediates, which are normally considered as food, are essential at fairly regular intervals, the human machine has pretty good storage facilities for many of them, and can continue to function—if rather poorly—for some time, even as long as a month, after the supply fails. But there are two other items which here on Earth we seldom consider, and which are of even greater importance than the fuel itself, because they are *not* stored.

The first and most important, is oxygen—for that hydrogen-oxygen energy yielding combination. The human machine, since it has absolutely no storage at all, stops in less than ten minutes without oxygen. The other is water—lubrication for the machine—and it is second in importance to oxygen in terms of time requirements, for the machine stops in less than five days without proper lubrication. Here on Earth we have only to breathe the atmosphere, and there's plenty of water splashing about, so the solution of this problem is simplicity itself. But later on when we get off this planet—

At last we have the whole story of the basic essential requirements for our human machine—at the very minimum, it is a collection of assorted chemical compounds and elements that totals two pounds per human machine day, plus adequate

water and oxygen. So, we know what we want, and the next question is the source of supply. Where and how, will we get it? Today we eat three square meals a day—if we can afford them—but will there be any changes? The answer to this depends, of course, on the particular environment we happen to be in; to avoid confusion let us take specific examples and see what the possible, as well as the probable, solutions are, and to begin with, suppose we stay on Earth.

Now the human machine has an excellent mechanism for securing the proper and adequate raw materials we have discussed, from a wide variety of natural products and disposing of the unnecessary or undesired remainder—it's called digestion. Almost any plant or animal tissue can be readily assimilated, even if it is almost entirely intact. This mechanism is an integral part of the body, going 'round and 'round all the time, and even if we avoid using it for other reasons, we still have to supply the energy that helps run it, so we may as well let it do some work. With this in mind, it is obvious that it would be rather stupid not to take advantage of the natural materials of the Earth's environment while we're here.

It might be suggested that this is a pretty inefficient way of doing things, and in one sense, it is. But first let us point out that one advantage of the system is that we can take advantage of the human's adaptability, in that it has ability to get these 3,000,000 calories out of other substances besides glucose, and is capable of converting other materials—as we saw, was the case with glycerol—into glucose. In fact, the total "waste" in the consumption end amounts to only about 5% of

the input being discarded as unsuitable.

So we do not need to change our present sources for any of the particular compounds necessary as fuel, and probably won't, except insofar as it might become economically desirable, as is now the case with some of the vitamins. And most of us will live to see the day when all the vitamin requirements are satisfied by synthetic products, but we may confidently predict that unless some serious cataclysm overwhelms the Earth in the next ten thousand years, we will still consume the same present-day materials for everything else.

This does not mean we will not alter the sources of these materials, for the real inefficiency of our present system is here in the production end. But the production processes are simple and convenient under the climatic conditions of the Earth, and they readily lend themselves to improvement in very simple ways. What may we expect in this regard?

FIRST we must distinguish between two classes of natural materials—plant and animal. All animals have essentially the same mechanism as our human machines, and require nearly the same materials, and consequently, the production of steer beef, say, is simply the problem of developing cheap and effective food supplies—almost identical with human food—and assisting the animal's growth as much as possible. But we saw the complexity of the human mechanism, and it might be bluntly stated here that we are not going to be able to tinker with the identical animal machinery for quite a while. So, whatever we say of developing human food applies equally to the development of food for animals, and means a slight increase in efficiency

of production of this sort of natural materials.

As for the plant sources, it so happens that they do not provide nearly as good a form of raw materials as do animal sources, especially in regard to the amino acids. But a fair selection and quantity is still available from plants, and since we can easily make up the necessary remainder with either animal sources or purely synthetic materials, any improvement in the production of plants would mean a very great step

that requires a lot of energy. It's photosynthetic, really, and the energy comes from the Sun as light quanta. But we have only the foggiest ideas about how the reaction itself works, and it will be long after we've developed space transportation that we'll have it down pat enough to just dump in any old energy and do the reaction in a test tube.

For the near future we're going to stick to letting the plant do its stuff in the same old way—with en-

"Daru Hyra hastily swallowed the few pills that constituted a full day's meals—"



in the over-all development of the natural materials useful as human fuel.

Today we stick seeds in a tank containing a solution of various synthetic substances and grow particular plants very efficiently, and of course, we will eventually do this sort of thing for all our natural plant materials. The main mechanism involved in plant growth is, as we shall see later, the exact reverse of that of the animal and human mechanisms, and we could say that in so "growing" plants we are really "synthesizing" our human fuel. We might term such a process a natural synthetic reaction. It is a reaction

couragements! We'll force-feed it, we'll illuminate it with artificial and intermittent light, we'll think up many new and intriguing ways of helping it do an efficient job of natural synthesis—but we won't tinker with the reactions themselves. This is true, for the same reasons we wouldn't cut into the ultimate energy yielding reactions of the human machines; the photosynthesis is not simply a chemical process which involves $\text{Energy} + \text{A} + \text{B} = \text{C} + \text{D}$, but a long, complicated series of reactions, which involve some obscure methods of energy transfer from one intermediate to another, and which necessitate all of

the right materials in the right places at the right times again.

Now the reason we discussed the ultimate chemical compounds required for the human machine so completely, was to indicate their exact nature, because there is a possibility we might want to do a straightforward chemical synthesis of our human fuel, and in general, the simpler the compound the easier it is to make. But we must not glibly assume that the knowledge of *how* to chemically synthesize something solves all the problems, because when we speak of "synthesis," we usually mean merely to produce the compound itself, without regard to any particular starting material. And making a compound can be very easy or very difficult, depending on what you have to start with—to start from the elements themselves doesn't make it any easier.

The worst case of chemical synthesis is probably that of glucose—sold today as corn sugar, or dextrose, it runs about eight cents a pound, retail—but remember that is a natural product! Completely artificial, synthetic glucose cannot be purchased anywhere today, and it would take a terrific amount of wasted energy, both human and otherwise, to make it—as a measure of the effort we can say it would probably cost around \$10,000 a pound. Of course, we can, and will, improve this a bit, but right now, nobody is trying to, and nobody's even going to give it a passing thought as long as the demand is completely nonexistent. In other words, there's a lot of work that's got to be done that isn't even being considered important! Of course, it may not be important—but we'd better get to some specific cases and see.

From the standpoint of our two

pounds of assorted substances then, we have two alternatives in every case: (1) we can get them the way we do now, with some improvements, i.e., by using natural processes to produce natural materials and let the digestion fish out the right compounds; or (2) we must synthesize them by chemical processes. But they are not equal alternatives, for we know nearly everything about the reactions needed for simple chemical synthesis and practically nothing about the natural photosynthetic ones! And so one might balance the two alternatives of natural vs. artificial synthesis thus: increased efficiency in the *use* of the natural processes is now so far ahead of the purely chemical ones from the standpoint of general utility here on Earth, that we may expect remarkable results to be attained, even without understanding the entire mechanism involved.

And while we may ultimately get it all worked out, from present indications that time will be long after we've found it necessary to keep human machines supplied with proper compounds under pretty severe conditions of environment, when it might be desirable to resort to the chemical process. Suppose we want a decent size colony on Venus, or Neptune, or the Moon? Well, there's the devil to pay.

FIRST of all, remember that our fundamental objective is merely to get fuel for our human machines, and we had three alternatives: find it, bring it, or make it. Now it's rather obvious that our Moon colony isn't going to find anything resembling food. They could bring it; that's just a problem in freight-ing and not very interesting—un-

less you're one of the starving colonists waiting for the food ship! Make it? What have they got to make it with? Just iron and nickel and cobalt and silicon, that's what the Moon is made of,* and you can't go around making glucose and other organic chemical compounds—which are in our case essentially carbon, nitrogen, oxygen, and hydrogen—out of these heavy metals by any method. (Oh, sure, there is a possibility; given lots and lots of atomic power it might be possible to go into transmutation in a big way, and make the necessary light elements out of the metals first. But that means whittling away at the Moon itself, and once you start that there would, undoubtedly, be a "Society for the Prevention of Whittling Away at the Moon," formed on Earth to put a stop to such vandalism.)

So fueling human machines on the Moon's a tough job, and as for the other planets, they present almost as difficult a problem. We might pretend, since we don't really know, that we would be able to find all the necessary elements in abundant quantities.† But this doesn't

make it much easier. We saw there are simple technical difficulties in the chemical synthesis of glucose from the elements, and while we can disregard the wasted energy as being of no importance to our Venusian colony with atomic energy to burn, there's still an awful lot of work which must be done in getting the completely artificial synthetic processes worked out, if they're not going to starve out there on Venus before they get them working.

In passing, we might point out that while there might very well be a considerable number of chemical compounds on Venus, or any other planet, they will all be inorganic compounds unless there is, or was, a "life" or "energy utilizing mechanism" capable of synthesizing organic compounds after the planet cooled down to less than 400° C. So the chances of finding available anything other than the elements, even remotely useful as a starting material in making glucose, let alone glucose itself, are pretty remote. There is a total of around 10^{10} different organic compounds which might exist—those really useful for a synthesis might total about 100.

How about making the human fuel on other planets with the natural synthetic processes we have discussed? That's a much better solution, in one sense, for it is workable today, merely requiring sealed areas built to reproduce the Earth with an atmosphere, a city, and some farm land, and, of course, it's perfectly sound. Essentially, that means transporting a chunk of the Earth up there, but it's a pretty stiff hauling job, because the amount of environment necessary for each human being is enormous. But on the other hand, such a solution of the problem is efficient, because it

* It would be very nice for the colonists if the Moon were made of green cheese, but this question has been settled conclusively by the prominent astronomer who took a careful spectrogram of the Moon and an equally careful spectrogram of some genuine green cheese. They were not identical.

† As a matter of fact it is possible that a distribution of elements more or less similar to that on Earth will be found elsewhere in the universe with great frequency. The argument may be summarized by saying that, given a hot—or cold, if you prefer—chunk of energy which is condensing—or expanding, if you prefer!—to matter, in the attendant confusion there may be an equal probability for the formation of all isotopes of all elements, and consequently all newborn suns may thus be practically identical.

But the unstable isotopes will decompose to become stable elements following the known laws of radioactive decomposition, so that the ratio of elements in any intact masses of matter of the same age will also be almost identical. In our solar system, of course, the planets were derived from the Sun at different times, and the non-homogeneity of this cooling mass of matter—the Sun—would inevitably result in their having different initial isotopic distributions and so ultimately, different elemental distributions.

disposes of another factor—the all important oxygen supply—for the plants conveniently liberate the oxygen in using the waste human carbon dioxide in its synthesis of glucose. This takes care of a couple of problems at once with a setup identical to that in the sealed aquaria one sees for sale as little globes, with a fish and some algae.

How much environment do we need? To a considerable extent, this depends on how soon we must build this human aquarium; right now, it might take more than a million cubic feet per person, which would mean an eight-story structure covering a whole city block for only thirty persons. But as we become more efficient at managing the natural synthetic processes the size of the environment required per human will gradually decrease, until we actually learn how to utilize the synthetic processes directly, *in vitro*. But it must be emphasized that this final step is a long way off—much farther than Venus!

And regardless of whatever progress we happen to make in the use of these natural processes for the production of human fuel, we must remember, that in any event, we must supply the raw materials for the process. Without entering into a long discussion of plant requirements, we might simply state that they are not too well known as yet, but include basically, the waste products of human and animal and bacterial metabolism. This oversimplification might lead to the assumption that the “closed system” aquaria for human machines is simple. It is certainly very efficient in the production of complicated compounds which are very difficult by chemical methods—especially remarkable, is the ability of plants to produce exclusively, right or left-

handed molecules—and the raw materials are only carbon dioxide and water; but the replacement, intermediate, and repair compounds which the plants require—and there are plenty we do not know yet—might have to be made by chemical methods—and so it would be just as well to synthesize the human fuel directly in the first place!

THERE ARE drawbacks to our use of the natural process, prior to the ultimate steps of using it *in vitro*. For instance, it is a sad fact that the plant won't just make glucose—it is going to make other compounds for its own purposes which are inefficient or useless as fuel for our human machines. This amounts to a waste of energy, since the energy used in making these unavailable compounds is lost as they are allowed to decompose or are destroyed by bacteria, the end products, perhaps, being used again as raw materials. It will be fascinating to watch the putting together of the jigsaw puzzle of the problems involved, and to see the rapid changes in the compromises between the two alternatives of artificial and natural synthesis, and to see the final solution. But it is difficult to tell what the whole picture puzzle is like from the few pieces we have fitted together, and what we see today may turn out to be something quite different tomorrow.

But it would be futile to delve into the possibilities of solutions to the general problem of fuel on other planets much further, for the very simple reason that we've got to get there first, and that means fueling the human machines in a spaceship. And not for just the trip there and back, either—after all, the ship must be the base of operations for a considerable period during exploration

and while the final process on the planet itself, is being set up.

The distinction between human fuel aboard a spaceship and on other planets is simply that of space. Space is valuable on a spaceship and that little "closed system aquarium" of a million cubic feet, which was required for our thirty humans on another planet utilizing the best we know today, is pretty big for putting inside a spaceship—and it can be said that we will only reduce this by some 50% in another thirty years after the war is over. The other alternative, chemical synthesis, isn't much better, due not only to the inherent difficulties of the synthesis itself, but also to the sad fact that chemical synthesis of this sort takes considerable human machine effort, thereby increasing the number of human machines aboard the ship!

It is obviously simple to avoid making the human fuel aboard by simply taking it along, if you have room for it; and we can but appeal to the spaceship designers, fictional or otherwise, to give us the necessary stowage space. For there is no doubt that sufficient food for an ex-

tended period can be carried along with a fair-sized group of humans; after all, Magellan managed to sail for ninety-eight days with two hundred and eighty men in five small boats on the food and water supplies they carried. To be sure, the crew was rotten with scurvy, and they had to eat the rats also aboard, but still, many of them survived. The Byrd polar expeditions indicate a present-day solution of the problem, but note that even without the necessity of supplying water or oxygen the food itself was pretty bulky. And certainly the human fuel problem on spaceships is not as simple as it has often been inferred.

For instance, in a recent story in *Astounding*, a crew of six set off on a twenty months' trip—ten out and ten back. The exigencies of the plot demand dumping the return trip rations a short way out, and we get a clear picture of the amount: our hero jettisons exactly one ton of rations. We saw that the daily fuel requirements for our sedentary human machine was two pounds a day, but with strenuous physical activity, the work output and en-



"I told you to stop saving the water condensed out of the air two months ago," Daru Hyra snapped.

ergy input increase to a maximum of about three times the minimum.¹ Consequently, six pounds of assorted compounds per human, per day, would afford but a reasonably safe supply. So our crew of six really needed $6 \times 6 \times 10 \times 30 = 10,800$ pounds or five tons, for that return trip; they had only one fifth of a safe supply, or one half of the absolute minimum.

LET us examine the exact case of what might be a typical problem; a big liner with a crew and passenger list totaling a hundred, on a year-round trip. On the basis of the safe supply we mentioned, the fuel compounds would take up about 70 cubic yards—the space occupied by a four-car garage. But what about the water and oxygen?

The loss of water from the body totals about two liters per day under ordinary conditions, and of this 20% is the product of the combustion of the glucose, while the remainder is the essential "lubrication" input, so that if no unusual losses occur, it would only be necessary to provide an intake of about 1.6 liters per day as basic minimum. But it must be noted that all of our condensed rations are dry, and would undoubtedly be more palatable with a fair water intake. With almost any physical labor or mental stress

¹ And don't write letters to Brass Tacks pointing out that the appetite apparently decreases under certain conditions. This has been consistently maintained by all hardy mountain climbers until the last Mount Everest expedition, which sought the advice of nutrition experts as to their food supply, and then, unfortunately, followed only part of it. As advised they took along plenty of vitamin concentrates, but they cut the expert's estimates of jerked meat and canned rations in half, because, they said, they'd always found on previous expeditions a serious loss of appetite at high altitudes. But when they got up about twenty thousand feet the expected decrease in appetite did not occur—in fact, they found themselves ravenously hungry. The answer? Vitamin B₁, which has an effect on the appetite and which they were getting in normal amounts at the high altitudes for the first time—the typical "puck ration" being very poor in B₁.

at all, sweating is bound to occur, and so for comfort and to have a little margin of safety, we might specify a gallon a day per person; our big liner then should have available 160 cubic yards of water.

The oxygen consumption on the minimum diet amounts to 400 liters; it corresponds exactly to the energy utilized, of course, and would go up to 1,200 liters for the high energy output of the six-pound-per-day fuel supply. However, it would obviously be wise to provide a considerable excess for emergencies and losses, as in opening and closing air locks, so we might take 1,600 liters per human day as the supply for our liner. This totals 60,000,000 liters of oxygen, and the next question is how to carry it. Compressed under high pressure it would require 10,000 steel cylinders or 500 cubic yards of space—almost out of the question. The most efficient way of carrying all this oxygen would be to liquefy or solidify it at low temperatures, for in our liner the absolute zero temperature of space is right outside. Heat insulation of particular compartments from the rest of the ship with vacuum jackets does not involve the difficult and tedious procedures of Earth for developing high vacuums—evacuation to the ultimate vacuum obtainable simply means turning a valve and allowing gas to flow out into space. Our oxygen supply would then amount to 110 cubic yards of liquid or 80 cubic yards of solid oxygen.

Thus we have the requirements for our space liner off for a year's trip with a hundred humans aboard—a total of 310 cubic yards of various materials, a chunk about the size of a not-too-small bungalow, which, of course, might easily be carried along. But note that of this total,

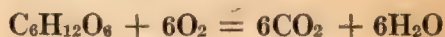
the oxygen and water requirements each amount to far more than the food supply itself, and consequently, to be able to eliminate them or decrease their size would be very desirable. In the case of the water this is simplicity itself, even today, and the oxygen problem is almost as easy. What are the facts?

As we saw above, the water output of the human machine is not only the input, but in addition, there is some 400 ml. per day—1,200 on maximum food intake—which is the product of fuel combustion. This means, then, that in the terms of the "closed economy" of a spaceship there appears a constantly increasing amount of water, and so why not make the output available for consumption? Perfectly simple—we need but to collect the waste liquids and fractionate out the water, with perhaps an absorption treatment to remove unpleasant volatile compounds carried over in the distillation.

Now the 2,000 ml. of water eliminated from the body per day under normal conditions, takes four routes: feces, 50 ml.; urine, 1,000 ml.; expired air, 300 ml.; and skin evaporation, 650 ml.; of these, the first is trivial and may be ignored, and the third is constant under nearly all conditions. Since the humidity inside the spaceship must be kept to a fairly low level for health and comfort, it is necessary to remove from the air the water eliminated by the last two sources, and as in submarines, this could conveniently be done with soda-lime—mixed calcium and sodium oxides—which also absorbs the carbon dioxide. Simply roasting the soda-lime would drive the water—together with the carbon dioxide—off

again and so that it could then be combined with the urine for our distillation and treatment. Thus, we have available from our process increasing amounts of water, day by day, as the supply of fuel materials decreases, and it is unnecessary to take any but the smallest reserve for the initial stage of the flight.

The oxygen problem is usually solved very neatly by "air fresheners" in most fiction, but the exact nature of these devices has seldom been disclosed. The problem, of course, is to supply oxygen and remove carbon dioxide from the air, and the simple solution usually visualized of letting the oxygen out of tanks and picking up the carbon dioxide with soda-lime, with perhaps a simple air-washing process to remove stale odors, is perfectly possible, but it requires that rather tremendous bulk of oxygen supply. Another solution which might occur to some would be to secure the oxygen from the excess water being produced by simple electrolysis. But this would produce only half the required oxygen! We can see this most easily by looking at the over-all equation which represents the energy yielding "combustion" process of the body for glucose:



Here we see the story at once: the oxygen requirement is 12 atoms of oxygen per molecule of glucose, but only 6 atoms of oxygen can later be recovered from the water, and we must find some way of getting at least an equal quantity of oxygen from somewhere else. Splitting up the carbon dioxide is not too easy: at a temperature of 2600° C. 50% of it decomposes to carbon monoxide and oxygen, but this would

give only half the required amount of oxygen, and at least 75% decomposition would be necessary. But there aren't any materials that would stand the higher temperatures necessary without going to pieces eventually, especially in the oxygen atmosphere. Removing the products and recycling the gas would be difficult, as would any other methods involving roundabout cycles of reactions to avoid having to use other materials, and none seem to offer much hope for a convenient and simple process.

BUT all of this about chemical processes is almost so much wasted words when we realize that the equation above, written backward, is the natural synthetic reaction we discussed for making glucose. One of the difficulties of using it for this purpose was that the $C_6H_{12}O_6$ didn't always turn out to be glucose; frequently it is cellulose, or some such substance which the human system can't utilize. But if we don't care what the plant makes, we can certainly do a lot of things about just getting it to grow fast, and thereby, use up a lot of carbon dioxide and water, and produce a lot of oxygen, and that's the solution of the "air freshener" problem; a very neat one, too.

Just how neat is it? Well, even as far back as 1918, a carbon dioxide uptake of 8 grams per square meter of leaf surface per hour was recorded; this was under strong illumination and a high carbon dioxide concentration of 5%. Today, we know even more, like the fact that intermittent illumination enables the so-called "dark" reactions of plants to proceed more in step with the photosynthetic ones, and increases of several hundred percent have been

recorded, so we might adopt a figure of 20 grams per hour as a feasible carbon dioxide uptake. And now, if we use a water plant which is capable of being grown very thickly, or even a grass, so that we have a high leaf surface for a particular volume, we might expect to get around 100 square meters of leaf area per cubic yard.

And now look what we have: a space of a cubic yard filled with the plant, under a fairly high carbon dioxide concentration, and with a high intensity intermittent illumination, and which is capable of converting 2,000 grams of carbon dioxide to the equivalent amount of oxygen per hour. But the hourly maximum output of carbon dioxide per human, on the basis of the maximum oxygen utilization we discussed, is only 100 grams!

However, we must make some reservations before we make the final step, for there will be considerable space taken up with attendant apparatus, and we may have to provide for replacement of the plant, et cetera. Feeding the plant is fairly simple, since we can utilize human digestive residues here. But even if we play safe and assign a space of 2 cubic yards to the total equipment, we still have a gadget which bulks only 1/10 cubic yard per person for an infinite oxygen supply—in the same space we could store only enough liquid oxygen for about a month!

There are some more accessories and widgeits—a widgeit is a wonderful gadget—which might be incorporated with our carbon dioxide process, and which would also solve the water problem. You remember that previously we considered soda-lime to take the moisture and CO_2 out of the air, but it is possible that

it would be done more conveniently another way. At high pressures, oxygen and nitrogen are not very soluble in water, but carbon dioxide is, and furthermore, any gas is cooled on expansion from high pressure. Thus we could install a high-pressure compressor in the air circulation system, and after compression the carbon dioxide is easily dissolved in water, the water being circulated to our plant processes.

At the same time near all the water will be frozen out of the air if it is expanded rapidly, and then the remaining nitrogen and oxygen could be combined with the oxygen from our plants and recirculated throughout the ship. We have thus removed not only the carbon dioxide and water from the air, but at the same time the water has been removed in the expansion process; with careful control, this water will be as pure as distilled water—and we even save the distillation process we previously suggested!

IT IS unnecessary to go into further details about the device, because the actual ultimate design and performance will rest on experimentation and trials, but it appears pretty clear that such devices will appear on submarines within a few years, and undoubtedly on the very first spaceships. The only remaining item that has to be taken as a supply on our spaceships is the two pounds of assorted compounds per human machine day which we have classed as fuel. There's only one trouble with this rather compact fuel—you can't feed human beings with it! Human machines, yes, and so long as you consider a human being a machine, it is quite true that the two pounds is all that is essential. But it is a foregone conclusion that

no one of us could ever manage to live for more than a couple of months on a diet consisting solely of glucose and other assorted compounds without ending in a strait-jacket with one of the more virulent forms of "space madness."

The use of flavors to give the glucose some variety is simple enough, and the remainder of the items might well be inclosed in capsules, so it wouldn't taste bad—it would just be dull. Golly, how dull! (Ask any biochemist who has gone on a particular standard diet for any length of time!) The human nervous system, with its complicated taste mechanism cannot be disregarded as easily as all this, and it is certain that some steps will have to be taken to make the human fuel we have talked about a little less like fuel and fairly close to what our nervous systems now recognize as food.

The first solution of this problem will undoubtedly be simply the mixing of these materials together with particular flavor concentrates until something vaguely palatable is produced. This adds to the bulk, of course, but there's possibly a little room just aft the crew's quarters. The ultimate step will be the chemical combination of these essential elements into various purely synthetic substances like our present natural materials in taste, but without any of the unnecessary compounds or extraneous compounds. What we would then have, would be meat that tastes like meat, bread that tastes like bread—but made from purely synthetic chemical compounds so built up that on digestion they break down into exactly the essential materials we have indicated before, with no waste and no excess. That is the real synthetic food of the future.

A CHAPTER FROM THE BEGINNING

By A. M. Phillips

A bit of a jaw—a fragment of skull—an eroded thigh bone from a few races of primitive man. How many other races has science missed? How many others struggled, rose—and fell?

Illustrated by W. Kelliker

*"That which made me was bred of ache
and bleeding,
Of ageless agony that shrieked and tore."
Eagle Sonnet—IV.
By Clement Wood.*

Today but one species of man inhabits the globe. All races, white, yellow, black, and even the primitive Australoids, so long suspected of being another, inferior species, preserved by isolation, are but racial and geographic variations of a single species.

This was not always so. In that remote past, when the first crude foreshadowings of men walked in a younger world, man was not confined to a single species. Pithecanthropus, Sinanthropus, and the Piltdown Man may have been contemporaneous. The Cro-Magnard and the brutish Neanderthalian certainly were. And these are only what is revealed by occasional discoveries of isolated deposits—a skull in Asia—a skull in Java—a skull and jawbone in England. The later man, the Cro-Magnon, the Neanderthal, left more—whole skeletons, implements, drawings. They buried their dead. They were higher in the scale, and may have believed in an after-life. Burial, at least, suggests such a belief. And skeletons buried in graves are much better preserved than those exposed to the whims of the elements. How many entire species of man have been lost because, lying where they died, exposed to the weather and animal scavengers, no single individual was preserved by fossilization? And how many, by chance so preserved, are still undiscovered? We know of five or six distinct species of primordial man. There were probably more.

Man has always hated and feared the alien, the stranger. Superior races today conquer and exterminate those not as advanced as themselves. The Tasmanian is

gone; other primitive races are following him. If this is true today how much more true must it have been in that primeval day when men of two separate species met? Differing far more widely than any difference in race, possibly derived from distinct ancestral forms, their one aim must have been to destroy each other. And such seems to have been the case, for it is believed that the Neanderthaloids, for thousands of years inhabiting the caves of western Europe, owe their final extinction to the superiority of the invading Cro-Magnon, who finally replaced them entirely.

So Nwug's breed, the Hairy Men, were disappearing. For untold thousands of years his people had roamed and hunted the plains and jungles, and then another species of man, which, brutish though they were, yet stood higher in the evolutionary scale, had invaded their domain. The invaders were the Hunters-with-Dogs. They looked more manlike, covered their less hairy skin with the hides of animals, and, equipped with the rudiments of superstition, dreaded the dark through some vague, half-recognition of mystery beyond them.

They thought quicker, acted in unison, and looked with hatred and contempt on Nwug's people, whom they christened "The Hairy-Men-Without-Words." This was not true; the Hairy Men possessed a language—a language of clicks and grunts, abetted by quick, expressive gestures—but their enemies never heard it. They never heard it because the Hairy Men reserved their spoken language for the rare moments when no danger threatened; when they crouched about a fire deep within some stone-barricaded cave and struggled clumsily to express that miracle slowly unfolding within them—the dawning intelligence.

For their practical uses, when they ranged across long reaches of jungle, they



The Hunter passed below, unseeing. His dog snuffed suspiciously—passed—and turned again!

used a language of gestures, almost as lucid to them as their vague gutturals, and far more rapid. When they hunted the fleet plains animals, and silence was requisite, they used this sign language, and when they were hunted and silence was even more vital.

THEY had taken his trail at last. They were hunting him down, as they had hunted his brother and his fleet-footed sister, as they had run to the death so many of the Hairy Men.

Nwug sat very still in the leafy shadows, gathering himself, drawing on all his resources, and sniffing the faint breeze which moved stealthily through the quiet forest. He had been sleeping, curled in a crotch in a forest giant, when some jungle pre-science of danger, some animal sense which his breed had brought with them from the dim, red welter of the past, from the lost and mysterious ancestor of man and ape alike—which the anthropologists of a far, far later day were to seek so vainly—had summoned him from the light slumber of the jungle creature to stare alertly, uneasily, at the cryptic stillness of the surrounding forest.

The dawn was not far off. Already a gray half-light stole through the motionless trees and giant ferns, giving the forest a wraithlike, unreal appearance. Somewhere nearby, a mastodon blundered into a thicket, its impatient, grumbling grunts mingling with the crashing of branches; and far off, probably on the upland plains, a carnivore roared reverberatingly—a last hunt before the dawn broke. A soft padding came from the forest floor as one of the night prowlers passed on its way to its lair. Far up in the highest levels of the forest an old male monkey boomed his welcome to the dawn as the first light of the rising sun gleamed on the topmost leaves.

Nwug's nostrils quivered and his ears twitched. He rose to his feet, a shadow among shadows, uneasy, restless, his slow mind seeking the source of the vague warning that had awakened him.

The familiar, matutinal sounds of the jungle his keen ears noted and dismissed. He sniffed the dawn wind as it slipped past him; probed the shadows with sharp, dark eyes. Abruptly the morning chorus of grunts and squeals and chirping ceased; an ominous quiet, pregnant with terror, hushed the jungle to silence while the long-drawn, mournful howl of the wolf dogs drifted through the still forest.

A swift terror swept the dawn man; his fingers tightened convulsively on the bit of flint they held, and a frightened growl rose and fell in his throat. The Hunters-with-Dogs were seeking the Hairy Men once more, and it was he, Nwug, that they hunted today!

He knew now why he had not caught their scent. They were downwind from him. And his clumsy brain, accelerated by fear, told him that he was their prey, for he alone of the Hairy People had bedded for the night in this narrow tongue of jungle that extended for miles out into the vast plains to the south. Unless he could break through them they would drive him down the long strip of forest and out upon the plains, where the swift wolf dogs would drag him down or hold him at bay until the Hunters came to take him!

With the wind carrying his scent to them the trees offered no refuge—they would trail him as swiftly as though he were already in view.

He must break through, get downwind of them, escape into the vast and ancient jungle to the north. Failing that, Nwug knew, he would

have to elude them until the darkness came again. He could escape in the darkness. For some reason, Nwug could not understand why, the Hunters feared the night.

But it would be a long, hard run, day-long if he could not break through their line, and he would need food or he would fail, as his brother and sister had failed, as all the others had failed. A dim vision of what failure meant drifted through the mind of the Hairy Man and the hackles rose on his short, sloping neck.

Nwug, in fact, was not quite a man. He stood somewhere in that strange, twilight land lying between that unknown ancestor and the true men to come long centuries later. He could not stand quite erect. His short, deep-chested body, on which the thick, dark hair stood rumpled and disheveled by sleep, leaned forward from the hips. From his shoulders the long, hirsute arms swung loosely, oddly at variance with his short and crooked legs and their knotty muscles. His brow was low and slanting, with heavy ridges above the eyes; his jaws prognathous, wide, extending almost into a muzzle. Long canines, the fighting fangs of the beast, were revealed as Nwug's loose, thin lips writhed into a snarl.

THE DAWN MAN swung himself down from his perch in the huge, old tree with a swift simian agility. From a trailing vine he dropped silently to the forest floor and paused with instinctive jungle caution, his dark little eyes, sunken under the heavy brows, alertly probing the shadowy undergrowth.

Satisfied, he made his way into the brush, moving in a crouching, bent-kneed walk that, awkward-appearing, was yet rapid. He moved with

purpose, heading toward a nearby stream, and snatching such edible fruits and berries as lay within reach. A small lizard scuttled across his path and Nwug pounced on it.

A tapir crashed into the jungle as he came to the stream, and a huge frog plunked resoundingly into the dark, still water. Something rustled the bushes on the opposite bank, but the gray mist hanging above the stream hid whatever it was from Nwug's quick glance. He crouched down on all fours and drank from the stream, thrusting his muzzle into the water and rolling his eyes upward in their sockets, keeping a ceaseless watch on the quiet jungle. He drank sparingly, knowing the run might be long and hard.

Nwug possessed imagination. Among the Hairy Men this was not common and many had paid for its lack with their lives. The dawn man remembered his brother, who, thrown into a mindless panic when the Hunters had trailed him, had flung himself off into the forest, not pausing to eat or drink. He had been run for miles, through the heat of the afternoon, until his thirst had grown to such proportions that, coming upon a jungle river, he had drunk so deeply that he could run no more and was overtaken a mile from its bank. An hour more and darkness, fast approaching, would have saved him. Nwug was not making the mistakes of his fellows. The Hunters would not catch him easily—perhaps they would not catch him at all.

He stood up, mastering the fear that tugged at him. Again that long howl, nearer now, rolled through the dim-lit jungle. Nwug grimaced in the direction of the sound, then set off toward the east.

The Hunters, he knew, would be spread out in a thin line, each of them with several wolf dogs, wild,

vicious, and but half obedient to their masters. Nwug hoped to slip around the eastern end of that line. If he could get downwind of them, his scent would be lost; he could take to the trees with the whole vast expanse of the northern forest open to him.

A break in the forest ahead told him he was nearing the plains, and the Hairy Man turned northward and swung up into the trees. He moved hesitantly, struggling with the terror that tugged at him, that urged him to flee rather than approach the merciless death he was facing.

A limb creaked beneath him and Nwug froze into immobility. Froze and listened, turning his head this way and that. From below, the sharp crack of a twig brought him down upon his branch, peering from behind it, the sweat starting on his tense body. In Nwug's nostrils the strong scent of the wolf dogs mingled with the warm, sour odor of the Hunters. They were close to him.

A HUGE wolf dog glided across the clearing beneath Nwug's tree. Another followed, to halt and sniff the breeze and snarl silently, revealing fearful saberlike fangs. Then it, too, moved stealthily away, disappearing in the brush.

A harsh-voiced bird was uttering at intervals a brief, senseless, rattling cry, and it had repeated its call many times before Nwug moved again. Then he rose slowly to his feet to peer and snuff and listen with painful intensity. At last he gripped the branch above his head and, hand over hand, swung himself toward the tree beyond. He dropped lightly onto a limb of the tree, and at that instant, from the dense foliage near the trunk, the head and shoulders of

a Hunter rose into view.

Each became aware of the other at the same instant. For a long, frozen moment of clamorous quiet they stared at each other. Nwug beheld a creature not unlike himself, but a little more human in appearance. The Hunter's pale skin was less mantled with hair, and he stood more erect than the Hairy Man. His brow slanted, but his jaws were less prognathous and his teeth, exhibited in a soundless snarl, were large and coarse, but lacked the long canines that graced Nwug's chinless jaw.

The Hunter was the first to move. With a wild yell that rang through the silent jungle he sprang clumsily to the branch that supported Nwug and scrambled awkwardly toward him.

With one supple movement the Hairy Man wheeled and swung himself toward the tree from which he had come. Seeing his prey about to escape, the Hunter, with another echoing scream of fury, discarded all caution and in a headlong charge flung himself the length of the branch and out into space. His heavier body struck Nwug's shoulders and tore the dawn man's fingers from the bough they gripped. Together, in a whirling, snarling, snapping tangle, the two plunged to the forest floor.

Instinctively, as they fell, Nwug's long arms were reaching for branches; several times he succeeded in seizing one, but their combined weight was too much for him and the branch was wrenched from his grasp. Though the action broke their fall and probably saved them from death, their impact with the ground was sufficient to stun the Hunter, who was underneath. His grip on Nwug relaxed and the Hairy Man, in a panic of terror, sped for the nearest tree, spurred by the roar-

ing bedlam that beat at him from every side.

The very trees seemed shaking before it. The deep-chested yells of the Hunters, answering Nwug's attacker, were almost drowned by the eager, savage baying of their animal allies. The swift wolf dogs were closing in quickly.

One of the huge brutes sprang full at Nwug from the brush at his left, and as he swerved to avoid it the dawn man collided again with the Hunter who had first attacked him. As they fell, Nwug's enemy gripped him and the two premen were instantly locked in a merciless, blood-mad embrace. And upon them both the wolf dog, murderous fangs flashing and with a continuous and hideous snarling issuing from its open jaws, launched its attack.

THE NEXT few bloody seconds were a blur to the Hairy Man. Past all fear, fighting for his life, he moved with the lightning speed of a striking snake. He fought as did the wolf dog, slashing and ripping with his long canines, never taking a grip. In an instant he had opened the Hunter's arm from wrist to elbow and was blinded by the rush of blood. Screaming in pain and rage, the Hunter beat at Nwug's bullet head with a throwing stone he held in one hand. Had one of those terrific blows found its mark the fight would have been over, for even Nwug's thick skull would have been crushed.

But that darting head was never still. The blows glanced from Nwug's sweated, hairy shoulders or dug meteorlike into the moist leaf mold of the jungle floor. Again those stabbing teeth slashed the Hunter, slicing through the flesh of his cheek to scrape on the bone. Bright scarlet spattered the leaf mold and the

Hunter gave vent to a strangled scream.

Nwug was not escaping unscathed. Although his thick hair protected him to some extent, he was bleeding in a score of places on arms, legs and shoulders. As the two premen rolled interlocked over the bloodied ground, the wolf dog circled them, lashing, striking, ripping with knife-edged, two-inch fangs. His savage face, contorted into a fanged mask of ferocity, was smeared and painted with blood, and so lost was he in the lust to kill that he struck at both combatants alike.

Nwug's chance came swiftly. The wolf dog drove his razor fangs deep into the Hunter's back, and with a piercing shriek of agony Nwug's opponent arched his back, flung up his head. Like a swooping hawk, the Hairy Man's jaws struck at his throat. The next instant the Hunter's lifeblood poured over Nwug, strangled him. He flung the limp, twitching body from him and surged to his feet in time to meet the furious charge of the wolf dog. The animal struck him on the chest, and one of Nwug's long arms wrapped itself about the wolf dog's body. His other hand caught the beast's muzzle. Nwug's compact body strained in a thrusting, Herculean effort and the wolf dog's backbone snapped with a report like the crack of a pistol.

All this had taken but seconds. Nwug, dazed, blinded with blood and the red mist of battle, stood irresolute, his bloodied fangs bared, his small head drawn down, protecting the jugular. Then realization of the death of his enemies came to him, and the Hairy Man flung up his head, broke into the shrill victory scream of his kind. He was all but unconscious of the frightful uproar sweeping through the jungle, but the advent of a horde of Hunters and

wolf dogs, pouring from the brush before him, swept the battle fever from his brain, sent him streaking for the trees, chattering in terror.

The Hunters came from the north and northwest. Eastward lay the open prairie. There was no way to turn but south. The hunt was on.

Gasping, panting, flecked with foam and blood, Nwug flung himself high into the branches, raced in a reckless, arrowlike flight southward. Below him, for a time, swept the gray ranks of the wolf dogs; then they vanished, outdistanced, and their long, savage baying drifted farther and farther to the rear.

Nwug sped on, swinging, dropping, hurtling long sweeps of air, his breath whistling through wide nostrils.

THE SUN was higher and its youthful ardor presaged a hot day. Nwug swung steadily on through the trees, but now he moved more deliberately. To continue at the mad pace at which he had been traveling would have meant swift exhaustion; his relentless pursuers would have permitted him to run himself out, would have followed inexorably, to overtake him at last when he could run no more, when, spent, exhausted, he would have fallen, helpless, under the killing teeth of the wolf dogs. Or been saved by the Hunters for some more grisly ceremony of their own.

He pictured the scene behind him. The Hunters, squat, heavy, bushy-browed and fierce-eyed, climbing awkwardly through the trees, ranging through the jungle and calling to each other with brutish eagerness as one or another found signs of Nwug's passage—the wolf dogs, on the ground, following their masters, taking Nwug's trail wherever he had been forced to the ground, voicing their deep howl when they found it,

snuffing with savage impatience when it vanished.

The Hairy Man shivered. He quickened his pace again, chancing daring leaps, landing surely, leaping again, the long muscles rippling across back and shoulders. So much he yielded to the sullen flood of terror which he resolutely restrained from engulfing him. Once that dark tide surged over him, he knew, he was lost.

From the higher levels Nwug could see before him the long, narrow peninsula of jungle, extending southward until it vanished in the blue obscurity of distance. On either side lay the vast prairies, yellow in the bright sunlight, and dotted with the tiny, dark shapes of feeding herbivore. Far to the east, towering high into the cloudless sky, rose a long range of nameless mountains, a few of which sported drifting plumes of smoke. Overhead, remote in the fathomless blue of the atmosphere, huge, condorlike birds swung slowly on motionless wings.

As noon passed the heat increased and Nwug was driven to the lower levels to escape the burning sunlight. The wind still blew from the south, and, coming from the shadeless plains, was as sultry as though it blew from a furnace. It carried with it a fine dust, raised by the numberless feet of the plains animals, that got into Nwug's throat and eyes. His once-glossy coat of hair was powdered with this dust, and about his shoulders and arms caked with dried blood. He was panting with thirst when his nostrils caught the scent of water.

On the forest floor was absolute stillness. The slow wind did not penetrate here and the jungle animals were hidden, drowsing through the midday heat. The dense ferns and deep banks of primitive shrubs

stood motionless, transfixed in silence.

Nwug stole forward silently, his reddened eyes alert, his nostrils flaring. He slipped through a tangle of lianas and came upon the pool lying like a flawless sheet of black glass on the jungle floor. As he crouched at its edge Nwug's quick ears caught a faint rustle of foliage behind him and with the instinctive, instant movement of the jungle creature the dawn man sprang, with a speed past belief, straight out over the pool. The stillness of the forest was shattered, ripped into quivering fragments, by a savage, thunderous, echoing roar that changed swiftly to a raging scream of frustration. The saber-toothed tiger had missed his victim.

The savage killer had been lying in wait by the pool. He stood, one terribly armed paw in the water, and watched the dawn man scurry into the trees.

Once safe, Nwug turned in a fury at having been denied the water he craved, and flung branches and abuse on the angry carnivore below him. The saber-tooth, its nine-inch tusks gleaming like ivory daggers, screamed and raged at its tormentor and made ineffectual attempts to drag its heavy body into the trees.

Nwug realized the uproar advertised his position, and swung off through the trees. Thirst tormented him, and a fresh scratch, long and deep, on the calf of his leg testified to the narrowness by which death had missed him.

Once his path carried him through the midst of a troop of monkeys, and their enraged, indignant shrieking aroused the jungle. A storm of gaudily colored birds rose with discordant cries to flutter about the disputants, and on the forest floor a titanotherium—a monstrous, rhinocer-

oslike animal with two spadelike horns set side by side on its nose—lumbered to its feet and stood peering and snuffling.

The old male leader of the monkeys screamed insults at Nwug and showered him with twigs and fruits, and the Hairy Man halted to grimace and chatter in return. The strong scent of a cat animal, attracted by the uproar, brought the dispute to a sudden halt, sending the monkeys, terror-stricken, flying off into the jungle.

The long howl of the wolf dogs rolled down the jungle, a grim and ominous reminder to the dawn man, and Nwug resumed his flight.

THE CHASE was tightening now. As the long, hot afternoon waned the Hunters drew closer to their quarry; they permitted Nwug no chance to rest, drove him steadily southward, steadily into the face of that torrid, dust-laden wind.

Nwug's arms ached, and in his dry mouth his tongue was swollen and stiff. Cracked lips shrank back from his protruding teeth, and his breath whistled harshly from open jaws. And the sun moved so slowly in the sky! There were still long, hot hours of daylight ahead.

The ground was rising, and occasionally the jungle was broken by wandering aisles of tall plains grass across which the dawn man shambled hurriedly, nervously conscious of his distance from the trees.

Once he was charged by a huge beast that looked like a gigantic rhinoceros; again by a horrible creature that seemed a blend of hyena and lion.

The pace grew faster. Closer and ever closer behind him came the howl of the wolf dogs. Then, faintly, Nwug could hear the shouts of the Hunters.

The forest was becoming more broken, and, as he neared the plains and the feeding herds, Nwug's encounters with the huge carnivora of his day became more frequent. Again he took to the highest levels, where the hot, bright sunlight gleamed and shone on his damp body. He sped on through the foliage, swinging from branch to branch, soaring lightly across sudden gulfs.

Behind him the Hunters charged recklessly forward, shouting triumphantly. Soon the Hairy Man would be driven out upon the plains. By sunset they would do their victory dance around the torn body of their quarry. The wolf dogs' medley of high-pitched yapping racketed through the forest, driving a horde of lesser game panic-stricken before them. Sudden bursts of furious squalling, and flurries of bloodcurdling shrieks, bespoke of their meetings with the ferocious saber-toothed tigers, who fled from nothing. The chase that day was costly, and many a Hunter and wolf dog left his mangled body as mute testimony to the tremendous power and fighting ability of these great cats.

Nwug raced on. Forest—a short space of open land—forest again. A giant, ancestral leopard sprang at him. The dawn man dived straight down through the branches, caught himself expertly on a lower limb, hurtled into a neighboring sassafras, and continued his speeding southward flight in a susurrant rustle of leaves and snapping twigs.

Shallow valleys drifted by. More and more the forest was giving place to large groves of trees interspersed with grass-grown fields.

The heat was intense. Beating down upon the leagues of swaying grassland, it was flung back in smothering waves. The sun-drenched forest drooped under it,

and over all drifted that scorching wind.

A sudden, compelling scream of triumph caused Nwug to glance back when halfway across an intervening field. The first of the Hunters was in sight. He stood motionless a moment at the edge of the grove Nwug had just left, then, with the long yell that informed his comrades he had sighted the quarry, he sprang in pursuit.

The Hairy Man broke into a desperate, awkward, bent-kneed run. The sands were running out, he knew. The long day of flight, the remorseless pace that had been set, were telling on him, were more and more rapidly draining the strength from his body. His wounds burned and the ache in his arms had grown to a savage, ceaseless pain. His dust-coated body drooped more and more forward. He was breathing with quick, sharp gasps, sucking the air through a dry, stiff throat that was slowly shrinking, slowly choking him. And his thirst had become a raging fever for water.

The long hunt was nearly ended, and for Nwug, the quarry, the last earthly sunset seemed fast approaching. He might as well turn and face his pursuers—end it now.

But behind that slanting frontal bone there burned a flame that could not recognize defeat, a spirit that would never surrender while life remained. It was that unconquerable courage that is the spirit of Man; without it he would never have emerged from the roaring, bloody age that knew his birth; he would have vanished and left the earth to the great beasts and natural forces with which he contended.

And so Nwug, preman groping his way from the shadowy mystery of the past, spent, gasping, driving steadily forward to what must be

his doom, snarled silently at his pursuers and raced for the cover of the next grove of timber.

THE HUNTER was close behind Nwug when the Hairy Man swung into the trees. Though heavier than the agile Hairy Man, the Hunter, because of the straighter, more human configuration of leg bones, could easily outrun him on the ground.

But among the interlaced branches of the forest giants Nwug was far swifter than his pursuer. While the Hairy Man followed almost a direct line, the Hunter was obliged to avoid the denser tangles of undergrowth and the thick boles of the trees themselves.

Consequently, Nwug drew rapidly away from his enemy. For a time the Hunter ran below him; then, seeing the distance between him and his quarry widening, he came to a sudden halt. Nwug was darting nimbly along a swaying branch high above the ground. With all the strength that remained in his breathless body, and with a force that spun him about, the Hunter flung the rounded, heavy flint he carried at the tiny figure so far above him.

The missile had been flung as a gesture of hatred, and with little expectation on the part of its thrower of striking the mark at which he aimed, but chance brought Nwug directly into line and the flying stone struck his ankle a numbing blow. So terrific and unexpected was the impact that it swept the Hairy Man from the bough to crash earthward amid a fusillade of snapping branches.

He whirled in the air, instinctively reaching, missed his grip, struck his head stunningly against a limb, and dazed and all but unconscious, still succeeded in catching a branch as it shot past him, only to have it break

with a deafening report a few feet beyond his hand. Still clutching the clublike branch end, but with the full force of his fall broken, Nwug plunged on, fell across a heavy limb, slid off and dropped to the ground, where he lay motionless.

All this the Hunter had watched in astonishment, but when Nwug fell into the concealment of the underbrush he loosed a howl of triumph and broke into a lumbering run toward the bush into which the Hairy Man had vanished.

Convinced of the death of his quarry, the Hunter dashed heedlessly into the brush, his eyes eagerly scanning the ground, and in that instant Nwug brought down the length of branch upon the Hunter's skull as though wielding a sledge hammer. Without a sound the Hunter collapsed lifeless, his brains strewing the brown leaf carpet of the forest. His body looked strangely deflated.

And upon him tumbled his executioner, for Nwug, desperately clinging to his slipping consciousness, had exerted the last of his strength to strike down his opponent. Silence descended on the forest but for the whisper of the warm wind in the higher levels, and the faint, remote whinnying of a faraway prairie animal. The sun was slipping down toward the western horizon, its slanting rays dappling the tree trunks with glowing patches of red gold, but Nwug lay unheeding across the body of the Hunter and presently, from some distant point to the north, came the voice of the wolf dogs.

A SMALL lemur scampered away when Nwug finally moved, and the faint rustle brought the dawn man to full consciousness. He twisted away from the body of the Hunter, staring at it uncomprehendingly, fangs bared for combat. Then, as



*Wildly he flung himself on the back of the horse
—and screamed his triumph as, broken ankle or no,
he left the maddened, howling Hunters behind!*

his memory cleared, Nwug attempted to rise to his feet only to find his left ankle swollen and throbbing with pain and totally incapable of supporting him.

He could run no more. With sundown but a few hours away he must stand and face his pursuers; prepare his weary, injured body for the final charge of the pack. But more important at that moment to the Hairy Man was the scent of water, nearby. Growling with pain, he hobbled toward it, aided by his long arms.

It was no more than a stagnant woodland pool, veiled with green slime, but Nwug lapped it as eagerly as though it were a mountain stream, ice-cold and sparkling. He splashed in it, sucked it into his dry throat, and the life-giving water flooded his parched body, revived him.

With reborn determination to sell his life dearly, Nwug drew himself into a tree. Slowly and painfully he climbed upward through the branches until he was high in the swaying crown, and there, fanned by the sultry wind, he prepared to make his last stand.

They might stone him from the treetop, to be ripped into shreds by the wolf dogs. But if they wished to take him alive, the Hunters would have to come after him, attack him in hand-to-hand struggle. Nwug, bloodied lips drawn back in a snarl, hoped they would try to capture him.

From where he sat he had a clear view of the next break in the forest, wider than any he had yet crossed. Dense ranks of yellow plains grass carpeted it, swaying in unison when some wandering current of air swept through the clearing, and threaded with a multitude of game trails.

A herd of animals was grazing in the clearing, but such a herd as no modern man has ever seen. Large, awkward, heavy-bodied and thick-

legged, they looked a composite of several unrelated species. Strangest of all was the fact that, though they were undoubtably herbivores, their feet bore huge, curved claws. Ages later paleontologists were to name them *Moropus*, and to ponder vainly over those puzzling claws.

Seeing them unmolested, three clothesses—monstrous piglike animals with heads a yard long—trotted into the clearing and fell to rooting and snuffling in the tall grass. Without warning a *moropus* flung up its head and gave vent to a piercing whistle and the entire herd thundered away onto the open plains. The clothesses held their ground, rumbling ominous warning, until the sardonic, long-fanged face of a saber-tooth appeared from the undergrowth of the opposite grove, when they turned and galloped sullenly away, casting sudden, angry glances over their shoulders.

Three of these formidable beasts seemed too much for even a saber-tooth, for the great cat hesitated, stared after the clothesses with round, luminous eyes, then, with a faint hissing snarl, drew back into the brush.

SOMETHING was struggling to formulate itself in Nwug's brain. He stared after the *moropus*, then at the spot where the saber-tooth had appeared. He grunted and grumbled, but whatever it was slipped from him, and he hauled himself upright, supported on his right leg, to peer northward through the trees. The Hunter he had killed must have been far in advance of the others, for as yet the occasional baying of the wolf dogs seemed no nearer.

With a subdued flurry of hoofbeats a half dozen or more primitive horses cantered into the clearing. They were slender, graceful animals,

about the size of a modern pony, and even more nervously alert than the lumbering moropus. Always one or more had its head up, snuffing the air and watching the flanking forests with bright, liquid eyes, while the others grazed.

Nwug watched them, envying them their strong legs, their swift gallop. And then again that idea stirred in the Hairy Man's mind, grew suddenly clearer. He broke into an excited gabbling, pointing at the horses, gesticulating, using all of the Hairy Men's crude language to clarify to himself the fearful and unprecedented action to which that idea was urging him.

For a while, under the stress of his emotion, he climbed aimlessly about the treetop, stopping to grimace and snarl toward the north, or to point at the grazing horses and then at his injured foot.

The long, rising howl of the wolf dogs was like a sudden, spoken warning. Nwug halted to listen, then began a rapid descent of the tree, ignoring the stabbing pain in his foot.

Cautiously, silently he crawled through the ground growth toward the clearing. As the trees thinned the lower shrubs became denser, expanding under the hot sunlight which here found its way to the forest floor. Nwug dropped flat on his stomach. Tensed to the utmost, using all of his skill and instinctive jungle knowledge, the Hairy Man writhed forward. When his head at last emerged upon the meadow side of the brush, he halted and remained utterly motionless for long moments.

The ranks of tall grass began immediately the bush ended, and the dawn man could see nothing but the flat, slightly swaying blades of grass before him. But his sensitive nostrils were flooded with the warm, sweet odor of the small horses, and

he could plainly hear the muffled click of their teeth, the soft sighing of their breath, and the nervous shifting of small hoofs.

With senses unbelievably keen, and with the uncanny jungle instinct his species still retained, Nwug examined and explored his surroundings. The saber-tooth that had alarmed the moropus had gone. It had been on the opposite side of the clearing, downwind, and no least suggestion of its spoor was borne to him. The horses were no more alert nor cautious than before—fear would have affected their scent glands.

Nwug crept out into the clearing, separating each blade of grass as he came to it. Any eye glancing across the unstable surface of the meadow would have noted no betraying movement, would have seen no more than a breeze-swept field, rolling idly beneath the wind's weight.

He did not head toward the horses—even his mastery of stalking would not have brought him within ten yards of them—but writhed his way westward toward the open prairie. The horses were slowly grazing toward the western mouth of the clearing, their progress slow but definite enough to assure Nwug that the herd's purpose was to utilize the clearing as a corridor from the eastern to the western plains. When the Hunters and their ferocious allies made their presence known, it would be westward the herd would flee.

MUFFLED by the intervening forest, a sudden shrill burst of yapping began. Nwug stiffened, then scrambled a dozen feet farther through the grass, depending on the alarming, unexpected baying to hold the herd's attention.

And so it did. As one the band of horses flung up their heads, cocked their ears and rolled wild eyes toward

the north. A few individuals trotted westward, to halt and stare again.

Swiftly, silently, Nwug snaked his way through the grass, teeth locked in final desperation. The far, dark line of the horizon was slicing into the swollen, red globe of the sun. That day had almost ended.

A wild and savage clamor, nearer, fiercer, broke the brief silence, and in it was mingled the high, clear wailing of the wolf dogs and the deep and vengeful roaring of the Hunters. They had found the body of the Hunter Nwug had slain.

The horses, although little fearing the Hunters or the dogs, whom they easily outran on the flat lands, were moving now, trotting in a body westward through the center of the clearing, keeping well away from the flanking forest. Unconscious of his presence, they bore down upon Nwug, their attention focused on the swiftly approaching, triumphant ululation of the hunt.

Nwug drew himself up into a tense crouch, the uninjured foot beneath him. Slowly he raised himself, steadied by his long arms, until the pointing ears of the horses came into view above the grass. They were moving faster now, breaking into a gallop. One sturdy little animal, short mane bristling between slender ears, ran far to the right of the herd. Nwug saw that it would pass him within arm's reach.

The rolling thunder of the small hoofs grew louder, faster. The Hairy Man was quivering, shaking in every limb as though with cold. It was his moment of greatest integration. Never again would all his faculties be so concentrated; never again would that brain, still undeveloped, still groping in a world where it was yet a stranger, succeed in unifying with such force and tension all its resources, nor would that wearied,

injured body ever again respond so lightly, so swiftly to his will.

Faster and faster sounded the beat of the hoofs. The animal nearest him was very close. Nwug crouched on his one sound foot, gripping the earth with fingerlike toes. Closer—closer—it was almost upon him.

The tensed, coiled muscles of the dawn man snapped, released. With a deep and sobbing cry he flung himself forward.

His flying body struck the little horse at shoulder level, and the animal swerved, screaming in panic. Nwug seized his mount blindly, gripping with teeth and hands, himself in a paroxysm of terror at this bucking, leaping, unfamiliar thing to which he clung. The other horses leaped forward, startled, sweeping into a terrified, flat-eared run. Westward they fled, toward the setting sun, and Nwug's mount pursued them.

At that moment the horde of Hunters and their savage allies broke from the forest, the dogs' jaws slavering, the premen giving tongue to a hideous chorus, an eager, bestial yelling.

In an intermingled mass they charged down Nwug's trail to the spot from which he had leaped upon the horse, to the place where the trail ended.

SMALL HOOFS flying, tails streaming in the wind of their passage, the panic-spurred herd of horses swept out upon the limitless ranges of the western plains. The clear light of evening glittered and flashed on their sweat-shining, coppery-hued hides, on wildly tossing heads and flying manes.

Behind them—but swiftly coming up, for the dawn man's slight body was no impediment to his sturdy little mount—was Nwug, riding the

legs he had borrowed, clinging grimly to a thing that made his swiftest flights through the trees seem slow and fumbling.

A Hunter, separated from the others; came out upon the extreme western edge of the forest. The herd flashed past him, and then he saw the thing that followed, a sight that held him speechless and astounded. A horse—and over that horse's arching neck was thrust a face, but such a face as that dumfounded Hunter had never seen before. It seemed a thing of bronze—a sculptured shape of metal in which, somehow, was caught the spirit of that stern, ultimate nobility common to all races and species of men; a basic character, larded over in the individual by the mists of personality, here seen as a stark, primal entity, stripped of all else.

The thick brows were drawn down; the eyes beneath them deep-sunken from exhaustion and pain, but gleaming with a fierce and fixed resolve and the determination to survive. The wide lips, slightly drawn back over coarse teeth, were held without trembling, the heavy jaws locked firmly together. All the flesh of Nwug's face was lessened, so that the bony structure beneath stood out

sharply, forming clear lines and hard angles.

The startled Hunter stood transfixed, his small eyes bulging. The others, caught by his tense, awed attitude, joined him, while the wolf dogs coursed in widening circles about the spot where the trail vanished.

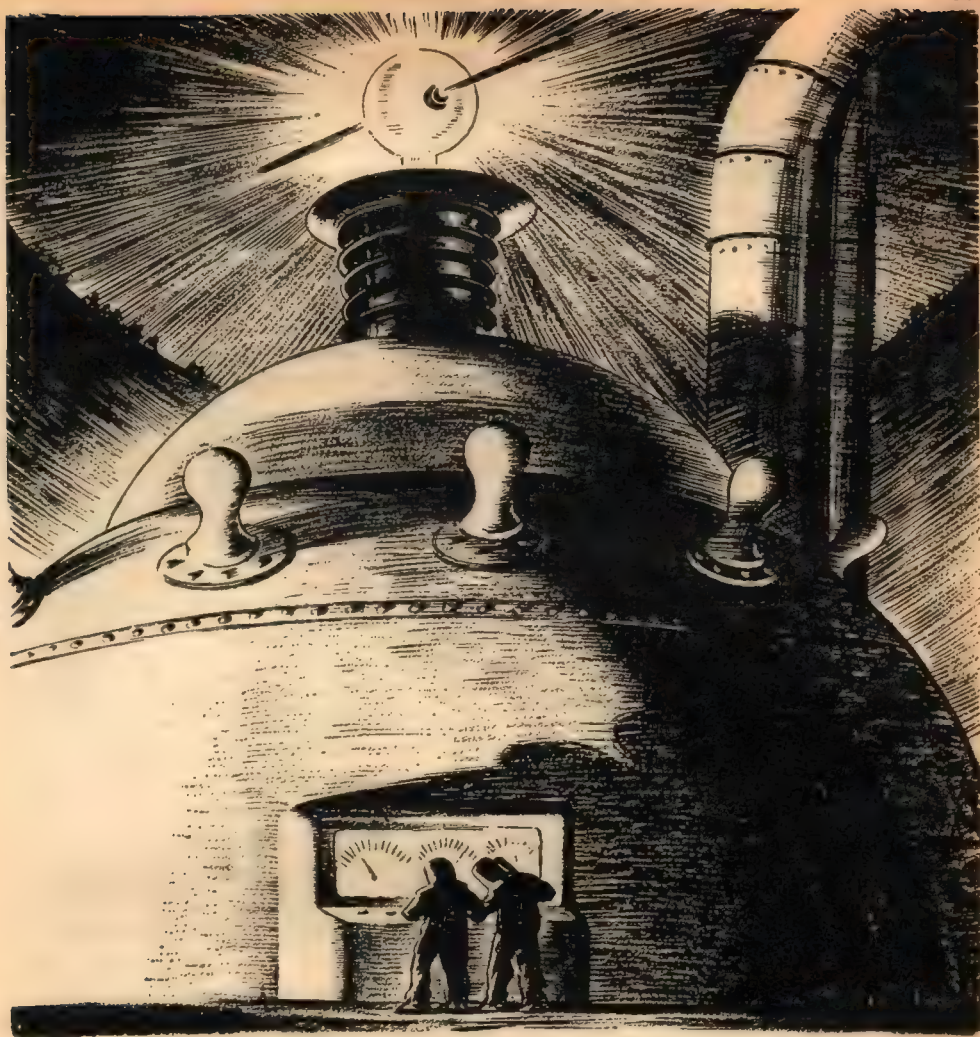
In answer to his fellows' quick, gruff questions the daunted Hunter pointed mutely after the wildly galloping herd. They stared, peering, doubtful of what they were to see, and slowly, before the distance had become too great, their unbelieving eyes beheld the figure of their quarry crouching astride his flying steed and already far out upon the plains floor.

And so, while his enemies watched and shivered in superstitious fear, Nwug rode into the last red glory of the sunset, and, though he knew nothing of that, into the dawning glory of the future.

One long and piercing scream, pregnant with a fierce exultation, drifted back to them, then the remote drumming of the small hoofs faded to a whisper and vanished.

The swift tropic night closed over the frightened Hunters, wrapping jungle and prairie in the mystery of the dark.





THE DWINDLING SPHERE

By Willard E. Hawkins

When change is slow to the lifetime of a man, he does not note or believing the steady vanishing—

Extracts from the diary of Frank Baxter, B S., M. Sc.

June 23, 1945. I thought today I was on the track of something, but
AST—7

the results, while remarkable in their way, were disappointing. The only thing of importance I can be said to have demonstrated is that, with my new technique of neutron bombardment, it is unnecessary to confine experiments to the heavier elements. This broadens the field of investigation enormously. Substituted a lump of common coal for uranium in today's experiment, and it was reduced to a small cinder. Probably

oxidized, owing to a defect in the apparatus or in my procedure.

However, it seems remarkable that, despite the almost instantaneous nature of the combustion, there was no explosion. Nor, as far as I could detect, was any heat generated. In fact, I unthinkingly picked up the cinder—a small, smooth buttonlike object—and it was scarcely warm.

June 24, 1945. Repeated yesterday's experiment, carefully checking each step, with results practically identical to yesterday's. Can it be that I am on the verge of success? But that is absurd. If—as might be assumed from the evidence—my neutron bombardment started a self-perpetuating reaction which continued until every atom in the mass had been subjected to fission, enormous energy would have been generated. In fact, I would no longer be here, all in one piece, to tell about it. Even the combustion of my lump of coal at such a practically instantaneous rate would be equivalent to exploding so much dynamite.

It is very puzzling, for the fact remains that the lump has been reduced to a fraction of its original weight and size. There is, after all, only one possible answer: the greater part of its mass must have been converted into energy. The question, then, is, what became of the energy?

June 28, 1945. Have been continuing my experiments, checking and rechecking. I have evidently hit upon some new principle in the conversion of matter into energy. Here are some of the results thus far:

Tried the same experiment with a chunk of rock—identical result. Tried it with a lump of earth, a piece of wood, a brass doorknob. Only difference in results was the size and

consistency of the resulting cinder. Have weighed the substance each time, then the residue after neutron bombardment. The original substance seems to be reduced to approximately one twentieth of its original mass, although this varies somewhat according to the strength of the magnetic field and various adjustments in the apparatus. These factors also seem to affect the composition of the cinder.

The essence of the problem, however, has thus far baffled me. Why is it that I cannot detect the force generated? What is its nature? Unless I can solve this problem, the whole discovery is pointless.

I have written to my old college roommate, Bernard Ogilvie, asking him to come and check my results. He is a capable engineer and I have faith in his honesty and common sense—even though he appears to have been lured away from scientific pursuits by commercialism.

July 15, 1945. Ogilvie has been here now for three days. He is greatly excited, but I am sorry that I sent for him. He has given me no help at all on my real problem—in fact, he seems more interested in the by-products than in the experiment itself. I had hoped he would help me to solve the mystery of what becomes of the energy generated by my process. Instead, he appears to be fascinated by those little chunks of residue—the cinders.

When I showed that it was possible, by certain adjustments in the apparatus, to control their texture and substance, he was beside himself with excitement. The result is that I have spent all my time since his arrival in making these cinders. We have produced them in consistency ranging all the way from hard little

buttons to a mushy substance resembling cheese.

Analysis shows them to be composed of various elements, chiefly carbon and silica. Ogilvie appears to think there has been an actual transmutation of elements into this final result. I question it. The material is simply a form of ash—a residue.

We have enlarged the apparatus and installed a hopper, into which we shovel rock, débris—in fact, anything that comes handy, including garbage and other waste. If my experiment, after all, proves a failure, I shall at least have the ironic satisfaction of having produced an ideal incinerator. Ogilvie declares there is a fortune in that alone.

July 20, 1945. Bernard Ogilvie has gone. Now I can get down to actual work again. He took with him a quantity of samples and plans for the equipment. Before he left, he revealed what is on his mind. He thinks my process may revolutionize the plastics industry. What a waste of time to have called him in! A fine mind spoiled by commercialism. With an epochal discovery in sight, all he can think of is that here is an opportunity to convert raw material which costs practically nothing into commercial gadgets. He thinks the stuff can be molded and shaped—perhaps through a matrix principle incorporated right in the apparatus.

Partly, I must confess, to get rid of him, I signed the agreement he drew up. It authorizes him to patent the process in my name, and gives me a major interest in all subsidiary devices and patents that may be developed by his engineers. He himself is to have what he calls the promotion rights, but there is some sort of a clause whereby the control reverts wholly to me or to my heirs at

his death. Ogilvie says it will mean millions to both of us.

He undoubtedly is carried away by his imagination. What could I do with such an absurd sum of money? However, a few thousand dollars might come in handy for improved equipment. I must find a means of capturing and controlling that energy.

Extracts from the diary of Quentin Baxter, president of Plastoscene Products, Inc.

August 3, 2065. I have made a discovery today which moved me profoundly—so profoundly that I have opened this journal so that my own thoughts and reactions may be likewise recorded for posterity. Diary-keeping has heretofore appealed to me as a rather foolish vanity—it now appears in an altogether different light.

The discovery which so altered my viewpoint was of a diary kept by my great-great-grandfather, Frank Baxter, the actual inventor of plastoscene.

I have often wondered what sort of a man this ancestor of mine could have been. History tells us almost nothing about him. I feel now that I know him as intimately as I know my closest associates. And what a different picture this diary gives from the prevailing concept!

Most of us have no doubt thought of the discoverer of the plastoscene principle as a man who saw the need for a simple method of catering to humanity's needs—one which would supplant the many laborious make-shifts of his day—and painstakingly set out to evolve it.

Actually, the discovery appears to have been an accident. Frank Baxter took no interest in its development—regarded it as of little ac-

count. Think of it! An invention more revolutionary than the discovery of fire, yet its inventor failed entirely to grasp its importance! To the end of his days it was to him merely a by-product. He died considering himself a failure, because he was unable to attain the goal he sought—the creation of atomic power.

In a sense, much of the credit apparently belongs to his friend, Bernard Ogilvie, who grasped the possibilities inherent in the new principle. Here again, what a different picture the diary gives from that found in our schoolbooks! The historians would have us regard Frank Baxter as a sort of master mind, Bernard Ogilvie as his humble disciple and Man Friday.

Actually, Ogilvie was a shrewd promoter who saw the possibilities of the discovery and exploited them—not especially to benefit humanity, but for personal gain. We must give him credit, however, for a scrupulous honesty which was amazing for his time. It would have been easy for him to take advantage of the impractical, dreamy scientist. Instead, he arranged that the inventor of the process should reap its rewards, and it is wholly owing to his insistence that control reverted to our family, where it has remained for more than a century.

All honor to these two exceptional men!

Neither, it is true, probably envisioned the great changes that would be wrought by the discovery. My ancestor remained to the end of his days dreamy and aloof, concerned solely with his futile efforts to trap the energy which he was sure he had released. The wealth which rolled up for him through Plastoscene Products, Inc.—apparently the largest individual fortune of his time—was

to him a vague abstraction. I find a few references to it in his diary, but they are written in a spirit of annoyance. He goes so far as to mention once—apparently exasperated because the responsibilities of his position called him away from his experiments for a few hours—that he would like to convert the millions into hard currency and pour them into a conversion hopper, where at least they might be turned into something useful.

It is strange, by the way, that the problem he posed has never been demonstrably solved. Scientists still are divided in their allegiance to two major theories—one, that the force generated by this conversion of elements escapes into the fourth dimension; the other that it is generated in the form of radiations akin to cosmic rays, which are dissipated with a velocity approaching the infinite. These rays do not affect ordinary matter, according to the theory, because they do not impinge upon it, but instead pass through it, as light passes through a transparent substance.

August 5, 2065. I have read and reread my grandfather's diary, and confess that I more and more find in him a kindred spirit. His way of life seems to me infinitely more appealing than that which inheritance has imposed upon me. The responsibilities resting on my shoulders, as reigning head of the Baxter dynasty, become exceedingly onerous at times. I even find myself wondering whether plastoscene has, after all, proved such an unmixed blessing for mankind.

Perhaps the greatest benefits may lie in the future. Certainly each stage in its development has been marked by economic readjustments—some of them well-nigh world-shat-

tering. I have often been glad that I did not live through those earlier days of stress, when industry after industry was wiped out by the remorseless juggernaut of technological progress. When, for example, hundreds of thousands were thrown out of employment in the metal mining and refining and allied industries. It was inevitable that plastoscene substitutes, produced at a fraction of the cost from common dirt of the fields, should wipe out this industry—but the step could have been taken, it seems to me, without subjecting the dispossessed workers and employers to such hardship—thereby precipitating what amounted to a civil war.

When we pause to think of it, almost every article in common use today represents one or more of those industries which was similarly wiped out, and on which vast numbers of people depended for their livelihood.

We have, at length, achieved a form of stable society—but I, for one, am not wholly satisfied with it.

What do we have? A small owning class—a cluster of corporations grouped around the supercorporation, Plastoscene Products, Inc., of which I am—Heaven help me!—the hereditary ruler. Next, a situation-holding class, ranging from scientists, executives and technicians down to the mechanical workers. Here again—because there are so few situations open, compared with the vast reservoir of potential producers—the situation holders have developed what amounts to a system of hereditary succession. I am told that it is almost impossible for one whose father was not a situation holder even to obtain the training necessary to qualify him for any of the jealously guarded positions.

Outside of this group is that great, surging mass, the major part of hu-

man society. These millions, I grant, are fed and clothed and housed and provided with a standard of living which their ancestors would have regarded as luxurious. Nevertheless, their lot is pitiful. They have no incentives; their status is that of a subject class. Particularly do I find distasteful the law which makes it a crime for any member of this enforced leisure group to be caught engaging in useful labor. The appalling number of convictions in our courts for this crime shows that there is in mankind an instinct to perform useful service, which cannot be eradicated merely by passing laws.

The situation is unhealthy as well from another standpoint. To me, it seems a normal thing that society should progress. Yet we cannot close our eyes to the fact that the most highly skilled scientific minds the world has ever known have failed to produce a worth-while advance in technology for over a quarter of a century. Has science become sterile? No. In fact, every schoolboy knows the answer.

Our scientists do not dare to announce their discoveries. I am supposed to shut my eyes to what I know—that every vital discovery along the lines of technology has been suppressed. The plain, blunt truth is that we dare not introduce any technical advance which would eliminate more situation holders. A major discovery—one that reduced an entire class of situation holders to enforced leisure—would precipitate another revolution.

Is human society—as a result of its greatest discovery—doomed to sterility?

October 17, 2089. It has been nearly a quarter of a century since I first read the diary of my great-grandfather, Frank Baxter. I felt



*The beams roared on, feeding steadily, inexorably,
the mass of Earth into the great converters—*

an impulse to get it out to show to my son, and before I realized it, I had reread the volume in its entirety. It stirred me even more than it did back in my younger days. I must preserve its crumbling pages in facsimile, on permanent plastoscene parchment, so that later descendants—finding our two journals wrapped together—will thrill as I have thrilled to that early record of achievement.

The reading has crystalized thoughts long dormant in my mind. I am nearing the end of the trail. Soon I will turn over the presidency of Plastoscene Products, Inc., to my son—if he desires it. Perhaps he will have other ideas. He is now a full-fledged Pl. T. D.—Doctor of Plastoscene Technology. It may be that power and position will mean as little to him as they have come to mean to me. I shall send for him tomorrow.

October 18, 2089. I have had my discussion with Philip, but I fear I bungled matters. He talked quite freely of his experiments. It seems that he has been working along the line of approach started by Levinson some years ago. As we know, the plastoscene principle in use involves the making of very complex adjustments. That is to say, if we wish to manufacture some new type of object—say a special gyroscope bearing—the engineer in charge sets the machine first to produce material of a certain specific hardness and temper; then he adjusts the controls which govern size and shape, and finally, having roughly achieved the desired result, he refines the product with micrometer adjustments—but largely through the trial-and-error method—until the quality, dimensions and so on meet the tests of his precision instruments. If the object involved is complex—involving two

or more compounds, for example—the adjustments are correspondingly more difficult. We have not succeeded in producing palatable food-stuffs, though our engineers have turned out some messes which are claimed to have nourishing qualities. I suspect that the engineers have purposely made them nauseous to the taste.

True, once the necessary adjustments have been made, they are recorded on microfilm. Thereafter, it is only necessary to feed this film into the control box, where the electric eye automatically makes all the adjustments for which the skill of the technician was initially required. Levinson, however, proposed to reproduce natural objects in plastoscene by photographic means.

It is this process which Philip apparently has perfected. His method involves a three-dimensional “scanning” device which records the texture, shape and the exact molecular structure of the object to be reproduced. The record is made on microfilm, which then needs only to be passed through the control box to recreate the object as many times as may be required.

“Think of the saving of effort!” Philip remarked enthusiastically. “Not only can objects of the greatest intricacy be reproduced without necessity of assembling, but even natural foods can be created in all their flavor and nourishing quality. I have eaten synthetic radishes—I have even tasted synthetic chicken—that could not be told from the original which formed its matrix.”

“You mean,” I demanded in some alarm, “that you can reproduce life?”

His face clouded. “No. That is a quality that seems to elude the scanner. But I can reproduce the animal, identical with its live pro-

tototype down to the last nerve tip and hair, except that it is inert—lifeless. The radishes I spoke of will not grow in soil—they cannot reproduce themselves—but chemically and in cell structure they image the originals.”

“Philip,” I declared, “this is an amazing achievement! It removes the last limitation upon the adaptability of plastoscene. It means that we can produce not merely machine parts but completely assembled machines. It means that foodstuffs can be—”

I stopped, brought to myself by his sudden change in expression.

“True, father,” he observed coldly, “except that it happens to be a pipe dream. I did not expect that you would be taken in by my fairy tale. I have an engagement and must go.”

He hurried from the room before I could get my wits about me.

October 23, 2089. Philip has been avoiding me, but I managed at last to corner him.

I began this time by mentioning that it would soon be necessary for me to turn over the burden of Plastoscene Products, Inc., to him as my logical successor.

He hesitated, then blurted: “Father, I know this is going to hurt you, but I don’t want to carry on the succession. I prefer to remain just a cog in the engineering department.”

“Responsibility,” I reminded him, “is something that cannot be honorably evaded.”

“Why should it be my responsibility?” he demanded vehemently. “I didn’t ask to be your son.”

“Nor,” I countered, “did I ask to be my father’s son, nor the great-grandson of a certain inventor who died in the twentieth century. Philip, I want you to do one thing for me. Take this little book—read

it—then bring it back and tell me what you think of it.” I handed him Frank Baxter’s diary.

October 24, 2089. Philip brought back the diary today. He admitted that he had sat up all night reading it.

“But I’m afraid the effect isn’t what you expected,” he told me frankly. “Instead of instilling the idea that we Baxters have a divine mission to carry on the dynasty, it makes me feel that our responsibility is rather to undo the damage already caused by our meddling. That old fellow back there—Frank Baxter—didn’t intend to produce this hideous stuff.”

“Hideous stuff?” I demanded.

“Don’t be shocked, father,” he said, a trifle apologetically. “I can’t help feeling rather deeply about this. Perhaps you think we’re better off than people in your great-grandfather’s time. I doubt it. They had work to do. There may have been employment problems—but it wasn’t the enforced idleness of our day. Look at Frank Baxter—he could work and invent things with the assurance that he was doing something to advance mankind. He wasn’t compelled to cover up his discoveries for fear they’d cause further—”

He stopped suddenly, as if realizing that he had said more than he intended.

“My boy,” I told him, speaking slowly, “I know just how you feel—and knowing it gives me more satisfaction than you can realize.”

He stared at me, bewildered. “You mean—you don’t want me to take on the succession?”

I unfolded my plan.

From the diary of Ran Raxler, tenth ranking honor student, North Central finals, class of 2653.

December 28, 2653. I have had two thrills today—an exciting discovery right on the heels of winning my diploma in the finals. Being one of the high twenty practically assures me of a chance to serve in the production pits this year.

But the discovery—I must record that first of all. It consists of a couple of old diaries. I found them in a chestful of family heirlooms which I rescued as they were about to be tossed into the waste tube. In another minute, they would have been on their way to the community plastoscene converter.

There has been a legend in our family that we are descended from the original discoverer of plastoscene, and this find surely tends to prove it.

Even the name is significant. Frank Baxter. Given names as well as surnames are passed down through the generations. My grandfather before me was Ran Raxler. The dropping of a letter here, the corruption of another there, could easily have resulted in the modification of Frank Baxter to Ran Raxler.

What a thrill it will be to present to the world the authentic diary of the man who discovered the plastoscene principle! Not the impossible legendary figure, but the actual, flesh-and-blood man. And what a shock it will be to many!

For it appears that Frank Baxter stumbled upon this discovery quite by accident, and regarded it to the end of his days as an unimportant by-product of his experiments.

And this later Baxter—Quentin—who wrote the companion diary and sealed the two together. What a martyr to progress he proved himself—he and his son, Philip. The diary throws an altogether different light on their motives than has been recorded in history.

Instead of being selfish oligarchs who were overthrown by a mass uprising, this diary reveals that they themselves engineered the revolution.

The final entry in Quentin Baxter's diary consists of these words: "I unfolded my plan." The context—when taken with the undisputed facts of history—makes it clear what the plan must have been.

As I reconstruct it, the Baxters, father and son, determined to abolish the control of plastoscene by a close corporation of hereditary owners, and to make it the property of the whole people.

The son had perfected the scanning principle which gives plastoscene its present unlimited range. His impulse was to withhold it—in fact, it had become a point of honor among technicians to bury such discoveries, after showing them to a few trusted associates.

Incomprehensible? Perhaps so at first, but not when we understand the upheavals such discoveries might cause in the form of society then existing. To make this clear, I should, perhaps, point to the record of history, which proves that up to the time of plastoscene, foodstuffs had been largely produced by growing them in the soil. This was accomplished through a highly technical process, which I cannot explain, but I am told that the University of Antarctica maintains an experimental laboratory in which the method is actually demonstrated to advanced classes. Moreover, we know what these foods were like through the microfilm matrices which still reproduce some of them for us.

The right to produce such foods for humanity's needs was jealously guarded by the great agricultural aristocracy. And, of course, this entire situation-holding class, together

with many others, would be abolished by Philip's invention.

We know what happened. Despite the laws prohibiting the operation of plastoscene converters except by licensed technicians and situation holders, contraband machines suddenly began to appear everywhere among the people. Since these machines were equipped with the new scanning principle, it is obvious, in view of the diary, that they must have been deliberately distributed at strategic points by the Baxters.

At first, the contraband machines were confiscated and destroyed—but since they were, of course, capable of reproducing themselves through the matrix library of microfilm which was standard equipment, the effort to keep pace with their spread through the masses was hopeless.

The ruling hierarchies appealed to the law, and to the Baxters, whose hereditary control of the plastoscene monopoly had been supposedly a safeguard against its falling into the hands of the people as a whole. The Baxters, father and son, then played their trump card. They issued a proclamation deeding the plastoscene principle in perpetuity to all the people.

History implies that they were forced to do this—but fails to explain how or why. There was a great deal of confusion and bloodshed during this period; no wonder that historians jumped at conclusions—even assuming that the Baxters were assassinated by revolutionists, along with others of the small owning group who made a last stand, trying to preserve their monopolies. In light of Quentin Baxter's diary, there is far better ground for believing that they were executed by members of their own class, who regarded them as traitors.

We should be thankful indeed that

those ancient days of war and bloodshed are over. Surely such conditions can never reappear on Earth. What possible reason can there be for people to rise up against each other? Just as we can supply all our needs with plastoscene, so can our neighbors on every continent supply theirs.

March 30, 2654. I have completed my service in the production pits, and thrilling weeks they have been. To have a part in the great process which keeps millions of people alive, even for a brief four weeks' period, makes one feel that life has not been lived in vain.

One could hardly realize, without such experience, what enormous quantities of raw material are required for the sustenance and needs of the human race. How fortunate I am to have been one of the few to earn this privilege of what the ancients called "work."

The problem must have been more difficult in the early days. Where we now distribute raw-material concentrates in the form of plastoscene-B, our forefathers had to transport the actual rock as dredged from the gravel pits. Even though the process of distribution was mechanical and largely automatic, still it was cumbersome, since material for conversion is required in a ratio of about twenty to one as compared with the finished product.

Today, of course, we have the intermediate process, by which soil and rock are converted at the pits into blocks of plastoscene-B. This represents, in a sense, the conversion process in an arrested stage. The raw material emerges in these blocks reduced to a tenth of its original weight, and an even smaller volume than it will occupy in the finished product—since the mass has been

increased by close packing of molecules.

A supply of concentrate sufficient to last the ordinary family for a year can now easily be stored in the standard-sized converter, and even the huge community converters have a capacity sufficient to provide for all the building, paving of roadways, recarpeting of recreation grounds, and like purposes, that are likely to be required in three months' time. I understand that experimental stations in South America are successfully introducing liquid concentrate, which can be piped directly to the consumers from the vast production pits.

I was amused on my last day by a question asked by a ten-year-old boy, the son of one of the supervisors. We stood on a rampart overlooking one of the vast production pits—several hundred feet deep and miles across—the whole space filled with a bewildering network of towers, girders, cranes, spires and cables, across and through which flashed transports of every variety. Far below us, the center of all this activity, could be discerned the huge conversion plant, in which the rock is reduced to plastoscene-B.

The little boy looked with awe at the scene, then turned his face upward, demanding: "What are we going to do when this hole gets so big that it takes up the whole world?"

We laughed, but I could sympathize with the question. Man is such a puny creature that it is difficult for him to realize what an infinitesimal thing on the Earth's surface is a cavity which to him appears enormous. The relationship, I should say, is about the same as a pin prick to a ball which a child can toss in the air.

From the introduction to "Our Eighty Years' War," signed by Glux Gluxton, chief historian, the Naphali Institute of Science. Dated as of the sixth day, sixth lunar month, year 10,487.

The Eighty Years' War is over. It has been concluded by a treaty of eternal amity signed at Latex on the morning of the twenty-ninth day of the fifth month.

By the terms of the treaty, all peoples of the world agree to subject themselves to control by the World Court. The Court, advised through surveys continuously conducted by the International Institute of Science, will have absolute authority over the conversion of basic substance into plastoscene, to the end that further disputes between regions and continents shall be impossible.

To my distinguished associates and to myself was allotted the task of compiling a history of the causes behind this prolonged upheaval and of its course.

How well we have succeeded posterity must judge. In a situation so complex, how, indeed, may one declare with assurance which were the essential causes? Though known as *the Eighty Years' War*, a more accurate expression would be *the Eighty Years of War*, for the period has been one marked by a constant succession of wars—of outbreaks originating spontaneously and from divers causes in various parts of the world.

Chief among the basic causes, of course, were the disputes between adjoining districts over the right to extend their conversion pits beyond certain boundaries. Nor can we overlook the serious situation precipitated when it was realized that the Antarctic sea-water conversion plants were sucking up such great

quantities that the level of the oceans was actually being lowered—much as the Great Lakes once found on the North American continent were drained of their water centuries ago. Disputes, alliances and counter-alliances, regions arrayed against each other, and finally engines of war raining fearful destruction. What an unprecedented bath of blood the world has endured!

The whole aim, from this time forth, will be to strip off the Earth's surface evenly, so that it shall become smooth and even, not rough and unsightly and covered with abandoned pits as now viewed from above. To prevent a too rapid lowering of sea level, it is provided that Antarctica and some other sections which have but a limited amount of land surface, shall be supplied with concentrate from the more favored regions.

Under such a treaty, signed with fervent good will by the representatives of a war-weary world population, is it far-fetched to assert that permanent peace has been assured? Your historian holds that it is not.

From the report of Ragnar Dugh, delegate to the World Peace Conference, to the 117th District. Circuit 1092, Rev. 148.

Honored confrères: It gives me pleasure to present, on behalf of the district which has honored me as its representative, concurrence in the conditions for peace as proposed in the majority report.

As I view your faces in the televisor, I see in them the same sense of deep elation that I feel, in the thought that this exhausting era of bloodshed and carnage has run its course, and that war is to be rendered impossible from this time

forth. Is this too strong a statement? I read in your eyes that it is not—for we are at last abolishing the cause of war—namely, the overcrowding of the Earth's surface.

The proposed restrictions may seem drastic, but the human race will accustom itself to them. And let us remember that they would be even more drastic if the wars themselves had not resulted in depopulating the world to a great extent. I am glad that it has not been found necessary to impose a ten-year moratorium on all childbearing. As matters stand, by limiting childbirth to a proportion of one child per circuit of the Sun for each three deaths within any given district, scientists agree that the population of the Earth will be reduced at a sufficient rate to relieve the tension.

The minority report, which favors providing more room for the population by constructing various levels or concentric shells, which would gird the world's surface and to which additional levels would be added as needed, I utterly condemn. It is impractical chiefly for the reason that the conversion of so much material into these various dwelling surfaces would cause a serious shrinkage in the Earth's mass.

Let us cast our votes in favor of the majority proposition, thus insuring a long life for the human race and for the sphere on which we dwell, and removing the last cause of war between peoples of the Earth.

From the memoirs of Xlar-XVII, Princep of Ples.

Cycle 188, 400-43. What an abomination is this younger generation! I am glad the new rules limit offspring to not more than one in a district per cycle. My nephew, Ryk-LVX,

has been saturating himself with folklore at the Museum of Antiquity, and had the audacity to assure me that there are records which suggest the existence of mankind before plastoscope.

Why will people befog their minds with the supernatural?

"There is a theory," he brazenly declared, "that at one time the world was partly composed of food, which burst up through its crust ready for the eating. It is claimed that even the carpet we now spread over the Earth's surface had its correspondence in a substance which appeared there spontaneously."

"In that case," I retorted sarcastically, "what became of this . . . this exudation of the rocks?"

Of course, he had an answer ready: "Plastoscene was discovered and offered mankind an easier method of supplying its needs, with the result that the surface of the Earth, containing the growth principle, was stripped away. I do not say that this is a fact," he hastened to add, "but merely that it may have some basis."

Here is what I told my nephew. I sincerely tried to be patient and to appeal to his common sense.

"The basis in fact is this: It is true that the Earth's surface has been many times stripped during the long existence of the human race. There is only one reasonable theory of life on this planet. Originally man—or rather his evolutionary predecessor—possessed within himself a digestive apparatus much wider in scope than at present. He consumed the rock, converted it into food, and thence into the elements necessary to feed his tissues, all within his own body.

"Eventually, as he developed intelligence, man learned how to pro-

duce plastoscene by mechanical means. He consumed this product as food, as well as using it for the myriad other purposes of his daily life. As a result, the organs within his own body no longer were needed to produce plastoscene directly from the rock. They gradually atrophied and disappeared, leaving only their vestiges in the present digestive tract."

This silenced the young man for a time, but I have no doubt he will return later with some other fantastic delusion. On one occasion it was the legend that, instead of being twin planets, our Earth and Luna were at one time of differing sizes, and that Luna revolved around the Earth as some of the distant moons revolve around their primaries.

This theory has been thoroughly discredited. It is true that there is a reduction of the Earth's mass every time we scrape its surface to produce according to our needs; but it is incredible that the Earth could ever have been several times the size of its companion planet, as these imaginative theorists would have us believe. They forget, no doubt, that the volume and mass of a large sphere is greater, in proportion to its area, and consequent human population, than that of a smaller sphere. Our planet even now would supply man for an incomprehensible time, yet it represents but a tiny fraction of such a mass as these theorists would have us believe in.

They forget that diminution would proceed at an ever-mounting rate as the size decreased; that such a huge sphere as they propose would have lasted forever.

It is impossible. As impossible as to imagine that a time will come when there will be no more Earth for man's conversion—

ATOMIC RINGMASTER

By Arthur McCann

***A fact article on a new analytical instrument
that may equal in importance both the mass
spectrograph and the spectroscope itself!***

IT being impossible to get to first base until you know first from third, science is impossible without analysis. The law of cause and effect is the difference between science and witchcraft, but to prove that a given cause always produces the same effect, somehow the several thousand other causes that tend to intrude must be hauled out and tied down elsewhere.

That's not so hard if you want to see if gravity always makes a ton of lead drop. In such an experiment, it is reasonably accurate to say that spring zephyrs won't seriously interfere. But there's the famous case of spectrum analysis, which seemed, for a while, about to blow out the window because the yellow line attributed to sodium did not always and exclusively occur when compounds known to contain sodium were tried. It simply occurred always. The effect appeared whether the putative cause was present or—apparently—not.

That time the spring zephyrs did interfere—and seriously. They wafted dried fragments of sea spray hundreds of miles, saturated the air of all Europe with invisible fragments of sea salt, and made every Bunsen burner in Europe slightly yellow with sodium.

When you work with atomic experiments—experiments depending on the actions of individual atoms, analysis has to work on the same

basis. Transmutation experiments give results horribly misleading with an ingenuity that seems positively directed to deceive. Radioactive barium appears and has, to all chemical tests that can be applied, the properties of radium. Some method a darned sight finer than precipitation by the quintillions of atoms must be applied before a few million radioactive barium atoms can be separated and distinguished.

The fact that there were half a dozen varieties of lead atoms could not be proven till the mass spectrograph, which separates one kind of atom from another, atom by atom, was turned on the problem.

There is no more accurate analyzer of atoms than the mass spectrograph. Theoretically, no more accurate method could be devised. It does in actual practice the theoretically perfect operation; it tests each single, individual atom, determines the identity of that single individual, separates it from all dissimilar types, and places it in a special category. It not only will not confuse radioactive barium with radium; it won't confuse lead 206 with lead 209.

It can't miss, because it tests each atom *as an individual*. All chemical methods necessarily operate on broad types, vast groupings. Silver atoms are separated from copper because silver chloride is extremely insoluble, while copper chloride remains in solution. Yet even silver

chloride leaves countless trillions of atoms of silver in solution. Enough to represent, perhaps, the entire product of a treatment designed to render silver radioactive.

The mass spectrograph is perfect?

Not by a darned sight. It requires that the atom to be tested be ionized, and that the resultant ion be projected in a narrow beam through an evacuated tube. Those two qualifications alone rule out millions of desirable experiments. You can't turn alcohol into a gaseous ion. It simply breaks down and ceases to be alcohol. You can't separate two kinds of complex molecules, because the molecules are cracked by the ionization first.

Then, with something like tungsten, which can be ionized, you have this difficulty: It is exceedingly difficult to turn tungsten into a vapor to be ionized, first. Second, when you do get the vapor, it will take a lot of work to ionize even a comparatively small portion of it. Finally, you must have a *beam* of ions—a jet of them. The only practicable way to do that is to have a small hole through which the ions enter the separating tube. That means that most of your hard-won ions are going to be lost trying to find their way through that hole.

The resultant stream of ions is a micro-micro proposition. Not unnaturally, if there is any other method that might possibly, perhaps, serve, the experimenter is going to try it first.

But sometimes that is the only way known. A present and highly important instance is the separation of uranium 235 from uranium 238. Both can be ionized, and the mass spectrograph will separate them. They cannot be separated chemically or by any other physical method known until very recently. Since it

is believed that U235 represents the possible long-sought atomic fuel, the substance that may permit of a self-sustaining atomic reaction, physicists naturally want to separate it.

This work is now being done by means of the mass spectrograph. It has been going on for some months, and a minute accumulation of U235, gathered literally atom by individual atom, is building up on the receivers of several mass spectrographs. The resultant of many hours of constant operation will be "a few micrograms," according to the men on that job now.

In this particular instance, incidentally, that will be plenty for the definitive test to determine whether or not U235 is the substance sought. The cyclotrons in which the final product will be tested similarly start operations with a beam of ions. Hence the mass spectrograph and the cyclotron, starting at the same point—a beam of ions—work at about the same rate. You don't have to start a forest fire to determine whether wood is combustible; you similarly don't have to burn a pound of U235 to determine whether a pound of it would burn atomically.

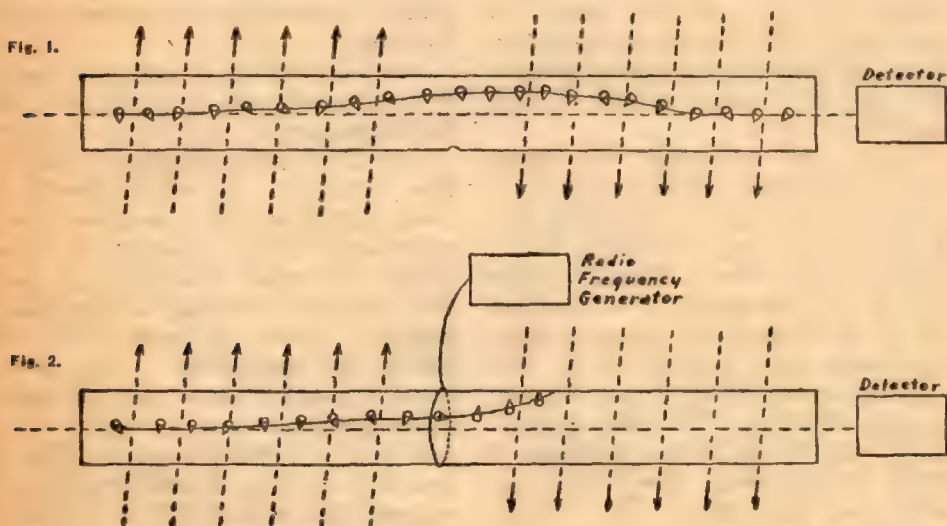
Since the work of separating U235 started, however, a radically different method of separating substances has been invented, but a method as sharp and atomically definitive as the mass spectrograph. Its great and immensely important difference is this: it works on neutral atoms and molecules, not ions.

Dr. Rabi, of Columbia University, has, like Edison in perfecting the incandescent lamp, taken a long-known, ineffective procedure and made it work beautifully. Recent news accounts mentioned it as "receiving radio signals from the atom"—a popularization of the fact that makes it somewhat vague.

ESSENTIALLY, the instrument follows the broad outlines of the mass spectrograph. The mass spectrograph starts with neutral atoms, volatilizes them into the gaseous state, then, by a powerful electric field, yanks one electron from each atom, leaving it with a single positive charge. These ions are accelerated by falling through an electric field, and those that happen to be moving in just the right direction travel out through a defining slit—simply

But the force of that deflection depends only on the speed and the single electric charge which each ion bears. Every ion is acted on by exactly the same force (so long as they travel at exactly the same speed—which is carefully arranged for).

But if a mixture of ions of weight 7 and 9 are being fired across, the weight-7 ions will yield much more readily to a given force than the more massive weight-9 ions. The single beam of ions will be divided



a slit which selects those traveling straight down the length of the tube, and hence constitute a beam of ions.

These ions pass toward a detecting target at the far end of the spectrograph tube proper. But they are moving electric charges, and across the mass-spectrograph tube is a powerful magnetic field. (In this, the mass spectrograph resembles a weak, small-size cyclotron.) The magnetic field deflects the moving electric charges as the magnetic field in a electric motor deflects the current-carrying wires of the armature and causes it to spin. Thus the beam of ions is bent aside.

into two, to be collected at separate "spouts" like milk and cream from a cream separator.

The new molecular beam analyzer developed at Columbia starts with a supply of the material to be tested. It is volatilized if not already gaseous—but, since the entire instrument works in a hard vacuum, even such normally solid or liquid substances as sodium chloride or mercury can be handled easily.

This gas is allowed to escape into a tube about a yard long, through a defining slit—again an arrangement to make sure that all the molecules are moving in straight lines to-

ward the far end of the tube. The preliminary lining up is done with the auxiliary apparatus off, and the accurate direction of the beam of molecules is first assured.

The long tube is evacuated to a high degree, so that the jet of gas is detected at the far end by means of an instrument which simply registers "substance is present." It consists of a heated filament which is slightly cooled by the arrival of the jet of gas.

The mass spectrograph ionizes the atoms before testing so that there will be some handle to take hold of. The molecular beam analyzer depends on another principle. Every atom and molecule is, by reason of the electrons in its atoms spinning around its nucleus, a tiny magnet. It is *not* a strong magnet. The thing can be acted on, however, to some extent. Therefore, if a powerful magnetic field acts across the yard-long tube, the beam of molecules will be slightly deflected.

But—*all* the molecules will be deflected. This effect has long been known; because it isn't selective, it was of no use as an analytical tool.

Now SUPPOSE that two magnetic fields are put across the tube, one acting to bend the beam upward, in the first half of the tube, and a second opposed to it, bending the beam downward in the second half of the tube. If all molecules react to them, the net effect will be nil—each canceled out by the other.

To make an analytical tool of the apparatus, some method of "tagging" the molecules is needed, something that will distinguish type A from type B. This is possible, because of another—also long-previously-known—effect; atoms and molecules are not only magnets, but might be

called magnetic tops; they have a spin. The spin is due partly to the electrons in the atoms, partly to nuclear effects, and, in dealing with molecules, partly to the mutual spacings and vibrations of atoms within the molecule. It is, in other words, complex. It's the sort of thing that leads to the spectrum of atoms in an electric arc.

But since the forces that can be applied to a molecule without disrupting it completely are low in magnitude, we can't start any very vigorous vibrations. Something slow and easy, perhaps—not up to the enormous frequencies of light waves, but in the radio-frequency range, perhaps.

Molecules will stand that. They will—or various parts of them will—respond to vibrations of those frequencies. But, because the energies of radio waves are very much smaller than those of light waves—if they weren't, the molecules would be disrupted—you can't detect directly, the radio-frequency reactions of molecules.

But—radio receiving sets don't send signals, but it's not hard to distinguish a set tuned into to station A from one tuned to station B. One responds to A's frequency—the other doesn't.

On the molecular scale, by impressing on the molecules a radio-frequency in tune to their natural period, changes in the molecule can be brought about which make them react to magnetic fields very differently. Naturally—they've been stretched, bent, compressed—but not quite broken.

The molecules are like tiny, spinning tops. In Fig. 1, the set-up of the straight magnetic deflection is indicated. The beam of molecules—represented as tops—bends upward, then, encountering the reversed mag-

netic field, bends downward.

In Fig. 2, the radio-frequency generator applies its energies at the mid-point, between the reversed magnetic field. At this point, the molecules tuned to the selected frequency are strongly affected. They bend, twist, turn—are, in various ways, distorted. After passing this point, they are no longer the same type of molecule they were. They are not affected by the second magnetic field, therefore, as they were by the first. Instead of being neatly and exactly bent back to the original course of flight, they are bent less, more, in another direction—in some way or another, differently.

The figure represents it as inverting the tops—they now react differently. The main point is, they can be separated from the mass of molecules as a different class, picked over, molecule by molecule, tagged, labeled, and sorted!

The separation, molecule by molecule, is as effective as the separation of the mass spectrograph—and doesn't require ions. Complex molecules can be tested.

But the uses of the molecular beam analyzer as a separator are but a small portion of its possibilities. Be it remembered, it works on the natural period of vibration of the molecules. Those periods are determined by the complex functions of its size, mass, distribution of mass—a hundred things.

Well enough; it makes it a tough problem to unscramble all those effects—but to find something that is a measure, however complex a measure—of those factors is another and highly important clue to what makes an atom tick.

The spectrum of an element is determined by its complex interactions of electrons and nucleus. Complex as blazes. But at least it's a clue—

a lead. They've unscrambled from that source alone a tremendous amount of knowledge of the inner workings of the atom. Far more, in fact, than they have learned from the atom-smashing experiments. The atom-smashing is something like a dissection of an animal; you find out what was in him, but it takes study of the live beastie to tell you what it did.

The molecular beam analyzer, by finding a function of the atom and the molecule which is dependent on its constitution in a complex way, studies the live beastie. It's an atomic ringmaster that makes the atoms and molecules perform, each according to kind, to its own particular cue.

It's nice to find some simple, logical, easily understood reaction of atoms. But a simple cause-effect relationship implies single, or very small number, interacting factors.

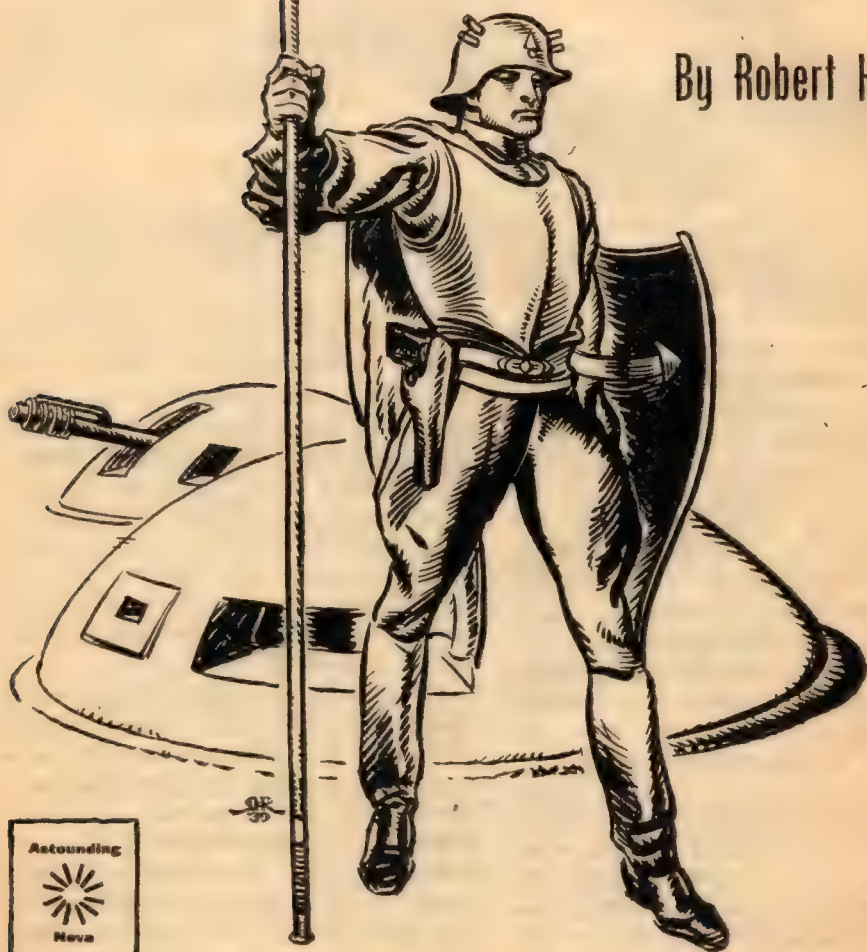
Atomic physicists like 'em complex. It takes more unscrambling, but you get something when you're through.

Chemists like 'em complex, too—but never before had a really good one. The spectrum will analyze for a few particularly hard-boiled, tough-shelled molecules and fragments of molecules, like CN, CH, et cetera, and the Raman effect, using light far in the infrared, and hence, somewhat less explosive to molecules, will distinguish particular types of atomic linkings, such as C-C from C-O or C=C. But the molecular beam analyzer, in effect, extends the spectrum far down into the radio range, making it possible to get a spectrum-recognition-signal from almost any substance that exists in vapor form.

It may do for molecules and molecular structure what the spectroscope has done for the atom and atomic structure.

♦♦ IF THIS GOES ON... ♦♦

By Robert Heinlein



The second NOVA story Astounding has offered—a story so exceptional in its presentation, so powerful and logical, that it wins the rare NOVA designation!

Concluding one of science-fiction's strongest novels—a tale of dictatorship in America, hiding behind the mask of a false cult. The logical and inevitable aim of perfected dictatorship and perfected propaganda: dictatorship that is itself a false religion!

IF THIS GOES ON—

By Robert Heinlein

Illustrated by H. Rogers

Synopsis.

At this period of future history of the United States, science is a monopoly of a priestly oligarchy, headed by the Prophet Incarnate, who is guarded by the Angels of the Lord, a crack military unit composed exclusively of commissioned officers, two of whom are Legate John Lyle and his friend Legate Zebadiah Jones, young graduates of West Point. Lyle's piety is shocked by the evidence of corruption which he finds at New Jerusalem, the Prophet's capital. He falls deeply in love with Sister Judith, a sacred Virgin in the Prophet's household. They are enabled to see each other by the friendly intervention of Sister Magdalene. They plan the escape of Judith from New Jerusalem, since Judith is in danger of execution because of her revolt after overhearing the Prophet's remarks to an associate which proved to her that the "religion" he represented was utterly false.

To accomplish this, John and Zebadiah join the Cabal, a revolutionary secret society. Judith is seized by the Prophet's inquisition, but is rescued by John with the aid of the Cabal. John is arrested and brought before the Chief Inquisitor, who administers ingenious scientific torture in an attempt to make him confess. John is himself rescued by the Cabal. He is given a new personality, that of a commercial traveler, by means of the advanced psychology of that

period, and is ordered to the Western General Headquarters of the revolution. He is picked up by the police in Denver, steals a rocket plane, and flees.

VIII.

AFTER the first flush of exaltation at having won through, I sobered down. My troubles weren't over, not by any means, and well I knew it. By an almost miraculous combination of circumstances I was in the air, with a good ship under me. Now remained the problem of how to get out of the air without being caught. As a matter of fact, weren't the circumstances a little too miraculous? Why had I been left loose in a room with an unguarded window? Was it not strange that a ship should be so conveniently at hand—with the ignition unlocked?

Of course, it might all be lucky accident, but it was distinctly possible that I had been allowed to escape in order that I might lead them straight to my comrades. All incidents up to date made that interpretation possible; any solution I made must include such possibility. On the other hand what was the situation if my escape was real—contrary to the intentions of the police? In that case I could expect hot pursuit and early apprehension, unless I did something clever and did it fast.

For catch me they would if I remained in the air. By this time pursuit pilots would have raised ship on

all four sides of me; they would have formed the front of their closed composite search curve; and with simple mathematical certainty they would locate me. If I did not ground on signal, they would calmly and efficiently blast me out of existence.

And I was not ready to die. Not only did I love life, but I had been intrusted with a message to deliver, an important one, Peter had told me; very important. It was up to me to deliver that message—I was really too busy at the moment to permit myself to be killed in a blaze of useless heroics.

So I must land. But that was almost as difficult as staying in the air. It is difficult to ground a rocket without a suitable field, and I was passing, at the moment, over the Great Divide. Colorado has more than fifty peaks on the order of fourteen thousand feet—practically as high as Pikes Peak, or higher—and it looked to me as if all of them lay in front of me. I couldn't possibly land the ship without crashing, and it was too late to turn and seek the prairies of eastern Colorado, or the plains of Kansas.

Suppose I did find a field before the searchers caught up with me; when the net closed in on itself, empty, they would assume that I had grounded, would shift the search to the ground with cordons around every field, and retiring search curves from each. The Prophet's police are thorough.

The only answer was logical, but seemed impossible—I must ground, but the ship must remain in the air. I must bail out, but the ship must go on and on, making a false trail, until it was blasted out of the air, and my pursuers wrote me off the books as dead.

In an old-fashioned, internal-combustion type plane, it would have

been simple; set the robot and jump. But a parachute jump from a rocket was another matter—there was no way to avoid the rocket blast. Even a second's exposure to the fury of those tortured, incandescent atoms was not to be considered. Rocket planes were equipped with 'chutes only to permit bailing out in case their cranky power plants failed; so far as I knew they had never been used from a rocket in power flight.

But bail out I must.

THE ABOVE considerations had occupied but a few minutes, perhaps five at the most. There is a drug secreted by one of the ductless glands, adrenalin I believe it is, that has the property of speeding up mental processes and reaction time in moments of stress. I was charged up to the point that the ship's speed of better than ten miles a minute seemed a bare crawl. I examined the dead-reckoner and saw that the bug was on a point seventy-five miles west of Denver. I changed course slightly to pass south of Salt Lake City, set the altitude for twenty-five thousand feet and clamped the robot.

So far, so good. The 'chute was in its breakaway clips over the pilot's saddle. I tore it down and put it on. Now to devise some way to protect myself from the blast. I looked around. I had hoped to find a fire-proof crash suit, or at least a high-altitude pressure suit, but it was wishful thinking—I had no reason to expect such equipment in a Sparrow Hawk—nor did I.

I sat down on the lazy-bench in the after end of the cabin and thought. There *must* be a solution—else there would be no more problems for me! My hand rested on the rough fabric of the seat cover. I stroked it absent-mindedly.

I sat up with a jerk, took out my

pen knife, and attacked the seat cover. It was a movable pad, stuffed with kapok, perhaps four inches thick, two feet wide, and six feet long—and covered with asbestos cloth!

A two-foot slit along one end enabled me to peel the cover back from the stuffing. I worked carefully to avoid tearing it, and presently had a fireproof sack big enough to hold a man—or a corpse.

The door would not open. I should have known it. Have you ever been outdoors in a sixty-mile gale? Then try to imagine the pressure of a six-hundred-mile-an-hour wind; even had I been able to open the door, I would never have gotten out of it alive. My body would have been sheared in two on the door frame like so much soft butter.

There was no time to lose. I could see the glint of the setting sun on the waters of the Great Salt Lake; possibly the police planes from Salt Lake City had me already in sight. I tripped the robot, and flung her about her gyros, tilting her nose up at a sharp angle. I set the robot to level off at fifty thousand feet. The wind pressure must be reduced, and the only practical means at hand was to go up where the air was thin. Whether or not I could stand an altitude of fifty thousand feet outside the ship without a pressure suit was not an issue I had time to consider.

When the plane leveled off I cut the speed to three hundred miles an hour and set the robot to pick up to six hundred in five minutes. At fifty thousand feet air pressure is about one seventh the pressure at sea level. Therefore a three-hundred-mile-an-hour wind would produce a wind pressure equal to a sea-level wind of about forty-three miles an hour. I could manage that.

ONCE the door was cranked open, and locked in place, I shrugged my way into the sack. I was already fighting for air and bleeding at the nose. My chest pained me intolerably, but it was too late to back out; I gathered in the mouth of the sack and bunched it together as well as I could to close it, then lurched blindly through the open door.

I started to count seconds.

And one!

A solid wall of searing heat struck me.

And two!

It melted away, leaving tingling heat behind.

And three!

I stopped floating, pressure built up on one side.

And five!

The neck of the sack was dragged out of my hand; with a thin, crackling rip the sack left me and I was falling free.

And six!

I dare not open my eyes, nor try to breathe, yet.

And seven!

It would take fifty-five seconds to make the drop in vacuo; how long would it take in the Earth's atmosphere? I didn't know.

And eight!

Panic hit me. Had it been eight seconds? Perhaps the first jar had knocked me out. I opened my eyes.

And nine!

No, I was just coming out of the exhaust cloud. The ground was still miles below.

And ten!

Why hold my breath any longer? I tried to breathe. The thin air was whipped away from me.

And eleven!

Cupped palms over my nose made a baffle for the air. I gasped, and choked on blood. Nevertheless the relief was immeasurable.

And twelve!

I rolled over slowly. A thousand feet, or more, above me the exhaust spread out in a giant plume, quilled with fire. That was my ship, already a mile away, and disappearing rapidly.

Thirteen!

The wind pressure and cold stung at my eyes. I had heard of frozen eyeballs. I covered my whole face with my hands.

Fourteen! — Fifteen! — Sixteen! — Sev'nteen!

Should I pull the ring? No, the farther away the ship, and the lower down I was when the 'chute opened, the better my chance of not being observed.

Doggedly I counted on, giving each syllable its full half-second beat. Every few seconds I snatched a glimpse of the ground.

At the count of fifty I could stand it no longer. My nerve was gone, and I had turned over on my back again and lost sight of the ground. I pulled the rip-cord ring.

I MUST have fainted from fright, or the jerk of the 'chute opening, or both. When I came to I was hanging safe in the harness of the 'chute while the ground slowly twisted and swung beneath me. I was still high up, more than a mile. Away to the west, the Sun just setting beyond it, was the Great Salt Lake. Between it and the Sun and stretching far to the south and west was the Great Salt Desert. Very much closer, not more than five miles away, lay another, smaller lake. That would be Utah Lake, and the good-sized town on the nearer shore must be Provo.

I was drifting rapidly toward Provo—but my plan required that I reach a town after dark, and on foot. It would be fatal to come parachuting in. I reached above me,

grabbed a double-handful of shrouds, and spilled some air out of the 'chute, causing a more rapid fall. I am no expert in spot jumping, but I brought 'er down that last mile in a hurry. About five hundred feet above ground I let go the shrouds and floated in.

Landing is deceptive. It is supposed to be roughly equal to a fourteen-foot tree jump. I drew up my feet in proper form, and rolled to my hands and knees, but nevertheless had the breath knocked out of me, and twisted my left wrist rather painfully.

Not that I minded it; I was completely happy simply to be on Mother Earth again, all in one piece. I lay still for a few minutes, then raised myself on one elbow and vomited. After that I felt better, and unstrapped the 'chute harness. I wanted very badly to conceal it, but I was in a cultivated field. Even if I buried it, it would be turned up by the farming. I had neither the strength nor the tools to bury it deeply. I finally hid it in some tall sagebrush that grew along a fence and prayed that it wouldn't be noticed for a few months.

I remembered having passed over a highway shortly before I grounded. After orienting myself by the afterglow of the Sun I headed for it. I trudged along, making hard going of the plowed field. After a couple of hundred yards I slanted into an irrigation ditch and almost fell in. A handkerchief, dipped in the water and applied to my bloody, soiled face, made a new man of me. I washed my hands, and brushed at my clothes.

A few minutes later I stepped out on the hard surface of the highway. The lights of Provo lay before me.

Provo is not a particularly large town and might not be expected to

have a particularly alert police force, but Utah has been a center of heresy and schism ever since the Mormon Church was suppressed, during the lifetime of the First Prophet. I took no chances. Before reaching the point where the highway entered the town proper I took to the fields again, and entered by a dimly lighted side street. Naturally I had hid from traffic on the highway, and now avoided pedestrians on the street. It lacked two hours of curfew; I must complete the first part of my program before the night patrol took the streets.

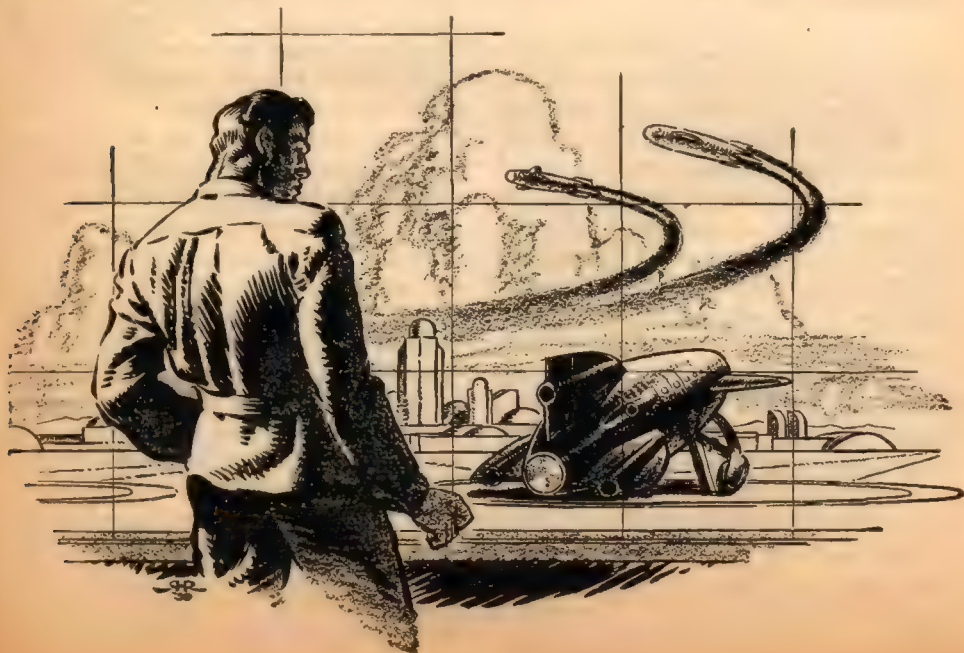
I wandered up and down the outlying residential streets for the better part of an hour before I found what I sought—some sort of a flier, parked outdoors and comfortably far from the nearest dwelling. I found it at last, a Ford family skycar, parked in a vacant lot. The nearest house showed no light.

I approached it on cautious feet, keeping to the shadows. The door

was locked, but a little patient jimmying solved that, and broke the blade of my penknife. The ignition was locked, also, but I had expected that. The United States government had given me a very expensive and practical education which included a detailed study of internal-combustion engines. I was handicapped by having to work in the dark, but twenty minutes sufficed to cut the locked switch out of the circuit with a jury rig that would permit the engine to run.

I wheeled the car by hand out into the street, while praying that no curious neighbor or patrolman would happen along until I got it there. Once in the street I slid into the pilot's seat, started the electric auxiliary and glided down the street and around the next corner, where I switched on the lights and drove away, as openly as any farmer returning piously from prayer meeting in town.

But when the houses had thinned



out sufficiently, I took advantage of a lull in traffic to switch off my lights and drive off the highway into an open field. I put several hundred yards between me and the highway, then ran my front wheel into an irrigation ditch. My take-off point had been determined for me!

The main engine started readily enough, and the rotor unfolded its airfoils with a dismal creak. She was slow on the take-off, due to the uneven keel on which she rested, but she made it—the ground dropped away.

IX.

THE CRAFT I had stolen was unquestionably a jalopy; old, not properly kept up, a bad valve knock in the engine, and a vibration in the rotor that I didn't like a bit. But she was running, and she had better than half a tank of fuel—enough to take me to Phoenix—which was all I could ask.

Worst of all was the complete lack of any navigating equipment other than an old-style, uncompensated Sperry robot, and a bundle of last year's strip maps such as are given away by the major fuel companies. There was a radio receiver, but it was out of order.

I did the best I could with the gear at hand. Phoenix was due south, or very nearly so, and four hundred ninety miles away. I estimated my drift—quite inaccurately, I am sure—and set the robot to make good a course of south. An additional setting for the pilot's alarm to ring a half hour before dawn was all that I could do.

Then I studied the sky to the north. There was no sight of pursuit. Apparently I had gotten away with it—so far. I showed no lights, naturally, and thanked Heaven that a helicopter was not the conspicuous

object that a rocket plane is. Then, being completely exhausted, both nervously and physically, I turned in on the after passenger bench and went at once to sleep.

I dreamed that I was still in the hands of the Inquisitor and that he was trying to break my nerve by eating juicy rare roast beef in my presence. "Confess," he told me, "and you shall have all you can eat!" I awoke with the acute realization that I had eaten last in Kansas City a good many hours ago. I got up to forage and glanced outside.

It was bright moonlight. We were just approaching the Grand Canyon. It was the first time I had ever seen it, and I think I may have seen it in the best possible way—from the air, by moonlight. I shan't describe it—if you have seen it, my effort would be superfluous; if you haven't, I haven't the skill to make you see it. But I forgot I was hungry.

We sliced across it in about twenty minutes and soon left it far astern. I rummaged around in the instrument-board compartment and in the lockers, and turned up a chocolate candy bar with almonds, and half a sack of peanuts. I ate them and went back to sleep.

When the alarm woke me, the eastern sky was beginning to gray. I turned the craft at right angles for a few minutes to check if my ground speed made good along the course south, and figured a bit on the margin of the strip map. If I were lucky and had encountered no great variation in wind during the night, Phoenix should show up in the next half hour.

Luck was with me again. I passed over an east-west range of mountains, and there, spread out to the right, was a low, flat desert valley, with a large city in the center—the Valley of the Sun and Phoenix!

I made a crash landing in a little twisted arroyo leading into Salt River Canyon. Half an hour later, after picking my way around stately giant cactus, and even more gigantic red boulders, I reached the highway which leads down the canyon and into Phoenix.

IT WAS a long, but not impossible, walk. For the first two hours there was very little traffic, all of which I avoided, but then I was overtaken by a freighter while on a sheer up-and-down piece. Since there was no way to avoid being seen, I gave the driver a nonchalant wave as he came abreast. He brought his ponderous vehicle to a quick, smooth stop.

"Want a lift, bud?"

I decided very quickly that I did, and said so.

"Climb in." He swung a light metal ladder down over the wide tread and I climbed into the cabin.

I had never been inside a freighter before and was interested to see how much it resembled the army's surface cruisers in its operation and controls. There were the same port and starboard Waterbury hydraulic universal speed gears controlling the traction surfaces, much the same instrument board—engine speed, port and starboard motor speeds, torque ratios, and so forth.

I didn't want him to question me about my affairs; I questioned him instead. "I've never been in one of these big babies before," I told him. "Tell me how it works, will you?"

"It's simple enough," he answered. "See these here speed bars"—and he indicated the two heavy levers rising out of the floor of the cabin and which he gripped, one in each fist—"they tilt the disks in the Waterburies, and that controls the speed of each tread. To steer I lay out one tread faster than the other. See?"

"I think so," I said to draw him out. "The Waterburies drive the freighter."

"Yes, and no," he went on. "It's a Diesel-electric hookup. The Diesel runs the generator at constant speed, and the generator charges the main battery. The port and starboard motors run off the battery and deliver their power to the treads through the Waterburies. The Waterburies ain't nothing more nor less than a device to deliver the power from the motors to the treads at whatever rate you need it; they're variable-speed gears that work hydraulically. This way the Diesel runs all the time at its most economical speed and the treads use power just as they need it. That's what makes it so cheap to run."

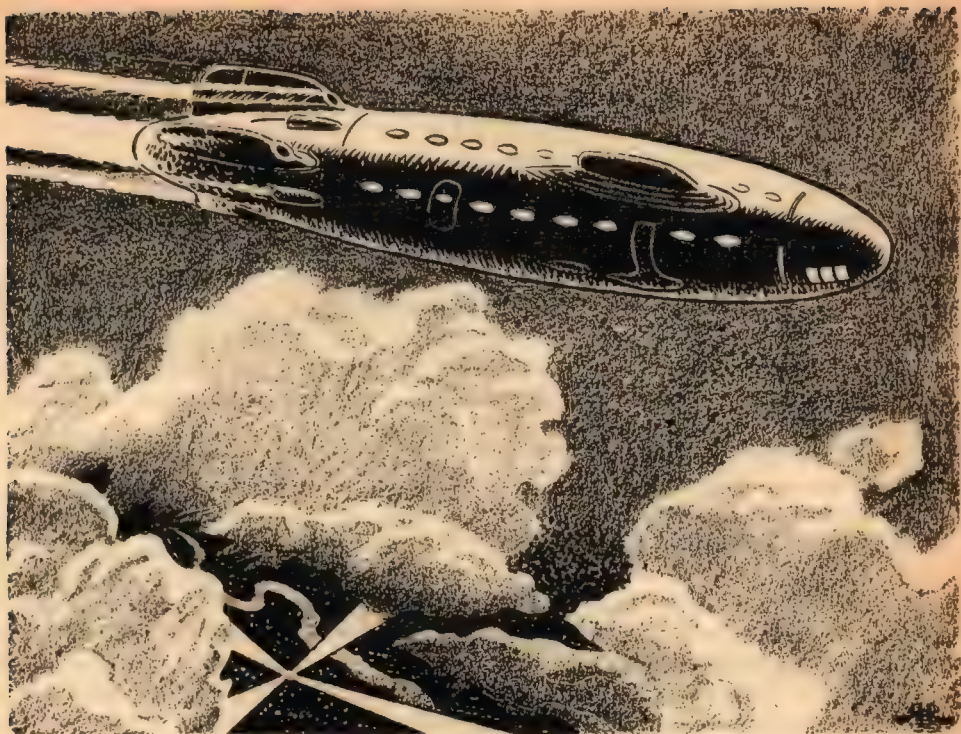
He went on at some length, pleased at my flattering interest. I filed away in my mind the idea that freighter jacks could be trained as military ground-cruiser pilots in short order, if the Cabal should need them. The miles flowed by and very shortly we were in the outskirts of Phoenix. We pulled off the road and ground to a stop. "All out," grunted my host, "breakfast, and fuel."

"Good idea," I agreed.

We consumed an improbable quantity of ham and eggs with wheat cakes, coffee, and big, sweet Arizona grapefruit. He wouldn't let me pay for his.

After breakfast I washed up, and made myself presentable. The visiphone book gave me the address of the South Side Tabernacle, and a map on the restaurant wall located it. We climbed back into the cabin, and my friendly fellow traveler let me down at a cross street just six blocks north of my rendezvous.

I hurried down the street and reached the church as morning services were starting. At last, I thought,



There were no ships faster than this one I'd stolen—but there were plenty to intercept it!

as soon as this service is over, I can reveal myself to the clergyman, and let *him* do the worrying for a while. It will be a relief.

I loitered after the service until there was an opportunity to speak to him. When the chance came I told him how much I had enjoyed the service, and shook hands, giving him the grip by which to recognize me.

But he failed to give me the sign in answer. I was momentarily so disconcerted that I almost missed the significance of what he said in reply:

"Thank you, my son. It is gratifying to a new pastor to hear that his ministrations are appreciated."

NEW PASTOR! I was dumfounded, rocked to my very bones. My only contact with the Brotherhood was

gone. What could I do? Without someone to hide me I was bound to be picked up in a matter of hours.

Even as cold panic seized me, and caused me to make desperate plans to steal another craft, and attempt to run the border patrol into Mexico, I heard my own voice prattling on, making casual conversation with the man.

"I did not know that you were new here. You see, I am a visitor here myself. Then you are not Reverend Baird?"

"No, I am afraid not, my son. Did you wish to see Reverend Baird?"

"It wasn't terribly important. Reverend Baird is an old friend of my uncle. I was to look him up and

pay my respects while I am here in Phoenix."

"That won't be so difficult; he is still in town. I've just popped in to take his pulpit while he's laid up."

I hope my face showed nothing of the wild leap my heart made.

"Perhaps, if he is sick, it would be better not to disturb him."

"Oh, no—it's just a sprained ankle. He'll be glad to see you. Here"—he hauled a scrap of paper and a stylus out of the folds of his gown, and commenced to write—"I'll give you his address." He put it in my hand. "Two streets over, and half a block down. You can't miss it."

"You are very kind."

"Not at all, my son. God go with you."

I found the place without difficulty, an old-fashioned, New England style frame house that looked out of place among the pseudo-Spanish dwellings surrounding it. It was set well back in a large garden, an untidy, friendly mixture of tropical flowers, shrubs, eucalyptus trees, and date palms.

I pressed the announcer, and heard the clicking whir of an out-of-date type of scanner.

The televox inquired: "Yes?"

"A visitor to see Reverend Baird, if it pleases him."

There was a short silence, then: "You'll have to let yourself in, my son; my maidservant is at the market. Straight down the central passage."

The door clicked and swung open. I blinked at the darkness, then proceeded down the hallway to a glassed-in veranda where an old man lay propped up on a day bed, sheet drawn over his bulbous middle, and one foot straight out before him. He lowered his book, and peered at me over his spectacles.

"What do you want of me, son?"
"Light."

COLD, rich milk washed down the last of the enchiladas. I reached for a cluster of muscatel grapes. Reverend Baird nodded approval. "You understand, then. Nothing to do until dark."

"I think so," I agreed. "Sanchez takes me out of town, and delivers me to certain of the brethren, who will see that I get to General Headquarters. My end of it is simple enough."

I left town concealed in the false bottom of a little vegetable truck. I was stowed away like so much luggage, my nose not an inch from the floor boards. We were stopped at the edge of town. I could hear brusque voices with an official ring in them, and Sanchez's impassioned Spanish. Someone rummaged around over my head and the cracks in the floor board gleamed with light.

Finally a voice said: "It's O. K., Ezra. He's Reverend Baird's handy man. Makes a trip out to the clergyman's ranch every night or so."

"Why didn't he say so?"

"He gets excited."

"O. K. Get goin', bud. Vamos con Dios."

"Gracias, señores." Sanchez's voice was liquid sweet. "Buenos noches."

At the ranch I transferred to a helicopter, no rickety heap this time, but a completely modern job, silent and well equipped. She was manned by a taciturn crew of two, who exchanged pass grips with me, motioned to me to get in, and took off at once.

We were in the air for about an hour. I had been told pointedly to remain in the passenger compartment, and was thereby kept in ignorance of course and speed. The squeal of a radio beam told me that we were

arriving. We slid down it, hovered for a moment, and bumped gently to a landing. When I stepped out of the car, I stared into the vortex of a tripod-mount blaster manned by grim, suspicious men.

My escort gave the password, I in turn was questioned in minute detail, a hoodwink was slipped over my head, and I was led away. We passed through a door, walked perhaps fifty yards, crowded into a compartment, and the floor dropped away with sickening suddenness. We left this lift, and climbed on a platform where I was told to sit down and hold on, whereupon we lurched away at a breakneck speed which, in my blindfolded condition, I found terrifying.

Then another elevator descent, a walk of several hundred yards, and the hoodwink was removed. I caught my first view of General Headquarters.

General Headquarters! Rather say fairyland—or the Gnome King's Palace! I had expected some sort of subterranean chamber because of the elevator descents—although it seemed possible that we might come out in some hidden, sunken valley—but in my wildest fancy I had not suspected what I did see—a natural limestone cavern of such size and magnificence as to beggar description.

I have heard tall tales and seen some remarkable photographs of the almost legendary Carlsbad Caverns which used to be a tourists' mecca before the earthquake of '96 wrecked them and made them inaccessible. I fancy that General Headquarters is as much as the Carlsbad Caverns were.

We followed a dimly lighted passageway, squeezing between dark-green stalagmites, ducking under creamy translucent curtains of onyx, skirting black pools in which grew

lily pads of living rock. Every turn brought into view some wonder more wildly beautiful, more awe inspiring, until the mind was fatigued, the emotions tired, and a poor, limited mortal could wonder no more.

Our path meandered around dark wet domes, mammoth sugar cones. We filed between two graceful columns, and debouched into the main cavern.

It spread out to the right and left for three hundred yards at least. The sides arched up to form a ceiling, lost in the gloom indefinite hundreds of feet overhead. And stretching straight before us ran the mighty floor, furlong after furlong, until it was swallowed up by blackness.

Later I was told that the main cavern was more than three quarters of a mile long, but the figure itself gives no conception of the immensity of this largest single room known to man.

On the floor of this Brobdingnagian hall, some distance away, and lower than where we stood, was a village, houses, barracks, office buildings, a power plant, busy figures and a hum of life—General Headquarters, nerve center of the revolution.

X.

I HAD EXPECTED subconsciously to be treated as some sort of conquering hero on my arrival at General Headquarters. I had pictured my new comrades as listening breathlessly to a modest account of my adventures, and congratulating me on my escapes, while thanking the Supreme Architect that I had been able to get through with the all-important message I carried.

I was vastly mistaken. An impersonal machinelike routine took me in charge on arrival, and whisked me through the necessary details to

make me a cog in the machine. I did get a chance to tell my story—to a recorder, automatic and unemotional. Flesh-and-blood men received the message I carried, but I was permitted no catharsis of self-importance thereby—I was unconscious, hypnotized as I had been when I received it.

This was too much for my curiosity; I asked the psychotechnician who operated me what the message was I had carried. He raised his brows.

"We aren't permitted to tell couriers what they carry."

I was vexed and showed it. "Don't the brethren trust me?"

"It's not that. It's for your own protection—the less you know that you don't need to know, the safer you are if you should be captured. You may be used as a messenger again; you are better off if you don't know too much. Do you know where this place is? Could you point it out on a map?"

"No."

"Neither do I. It is not needful for us to know; therefore we weren't told. Besides which," he went on, "the message you carried was not of any special interest—mostly routine reports duplicating stuff that we have already received by faster means."

"Routine stuff? Lodge Master Peter told me that I carried a message of great importance."

The technician looked puzzled, then his face cleared, and he smiled. "I think I understand. You did carry a message of extreme importance—to you. You carried your own credentials hypnotically. Had you not had them you would have been quietly eliminated without ever being brought to consciousness. We can't afford to depend on passwords and grips alone in this business."

I felt a cold wind through me.

WITHIN twenty-four hours I had completed my reports, been examined physically, been assigned to quarters, and found myself, with no loss of time, at work—repairing and adjusting blasters, pistols, squad guns, and siege guns. I was a little dazed by the speed with which things happened, but it was useful work, and it seemed good to handle calipers and feather gauges and micrometers again after the futile pomp of New Jerusalem.

Just before dinner after my first day's work I drifted into the common room and looked around for an unoccupied chair to loaf in while waiting for the gong. I heard a familiar baritone voice sing out my name. "John! John Lyle!" And striding toward me was Zebadiah Jones, good old Zeb, large as life and face split with a grin.

He pounded me on the back, and I pounded him. We exchanged affectionate insults.

"When did you get here?" I asked him.

"Me? I've been here about a week."

"So long as that? You were still at New Jerusalem when I left. How did you do it?"

"Easy. I was shipped through as a cadaver, in a state of deep catalepsy, sealed up in a coffin, and marked 'contagious.'"

I told him about the adventures and vicissitudes of my trip. He was properly impressed and made up for the blow to my pride that my off-hand reception had been. Then I asked him what he was doing.

"I'm in the Propaganda Bureau," he told me. "Just at present I'm engaged in writing a series of intimate articles on life in the palace of the Prophet. Very respectful and respectable articles they are, too."

My face must have expressed my

The wave of blinding, searing heat passed. I counted—then pulled the ripcord. Far away already, I saw the blazing jets of the retreating, robot-guided ship—



failure to understand, for he went on: "I tell all sorts of things about the private life of the Prophet and his assistants; how many servants they have, how much it costs to run the palace, about the complicated

ceremonies and rituals—all of it perfectly true and told with unctuous approval. But I lay it on too thick. The emphasis is on the jewels, and the solid-gold trappings, and all the expensive paraphernalia. All the way

through I keep telling the yokels what a privilege it is for them to be permitted to pay for all that junk, and how flattered they should feel that the Prophet lets them take care of him."

"I begin to see. Then what?"

"We syndicate this stuff in the little local papers in the back country of the Mississippi Valley, and in the deep South, and New England—that is to say, among the poorest and most puritanical part of the population—people who are absolutely convinced that poverty and virtue are the same thing. It grates on their nerves; in time it ought to make doubters out of them."

"Little things like that?"

"Sure. You can sway a hundred men by appealing to their prejudices to the one you can convince by sweet reasonableness. It doesn't have to be a prejudice about an important matter either—for instance, you savvy how to use the connotation indexes?"

"Well, yes and no. Something to do with the emotional responses associated with words, aren't they?"

"In a general way, that's it. The emotional connotation of any word is a complex variable function depending on context, age and sex and occupation of the listener, the locale, and a dozen other things. An index is a particular solution of the variable that tells you whether or not a particular word used in a particular fashion to a particular type of listener will affect that listener favorably, unfavorably, or simply leave him cold. Statistical research in this stuff provides us with the means to choose language best suited to play on the emotions. In these articles I invariably use language that will annoy the reader—and without him realizing that he's being worked on."

"It sounds good, but I don't quite

know what you mean by it."

"I'll take a gross case. Consider the commoner Anglo-Saxon monosyllables, the kind naughty little boys write on fences. You can't use them in polite society; you would give grave offense. Yet the Latin-derived synonyms, *meaning exactly the same thing*, can be used almost anywhere, and circumlocutions are always permissible. Which is another way of saying that those Anglo-Saxon words have a very high negative index.

"Of course, I can't use anything as blatant as that—it would give the show away—but I can and do use words that will irritate a particular class or locality. Since the stuff I write is all about the Prophet, lauding him to the skies, the irritation is transferred to him. It cuts way down below a man's conscious thought, and appeals to the taboos and fetishes that infest his subconscious."

"It sounds like heap big medicine," I commented.

"It is, fella, it is. There is magic in words, if you know how to use it."

I DIDN'T STAY in the Department of Ordnance and Gunnery very long. About ten days after my arrival I was sent word to report to the office of the commander in chief. I hurriedly changed my clothes and did so. I was ushered in after a short wait.

I stepped into the office, clicked my heels, and saluted, and received a surprise second only to my first sight of General Headquarters. Advancing to meet me, hand outstretched, was my old friend, Colonel Huxley, head of the Department of Applied Miracles when I was a cadet!

"John Lyle!" he smiled. "I'm glad to see you! Come, sit down, and tell me about yourself."

"Colonel—I mean General," I

stammered, "I thought you were dead."

"Dead colonel into live general, eh? No, I'm very much alive, although I am listed as dead. That is what they often do when an officer disappears. It looks better."

"But why in the world would you be in the Cabal?"

"Does that seem strange to you? I wouldn't join the ministry, you know; and the hierarchy doesn't like it when an outsider knows too much about the more abstruse branches of physics and chemistry. I had perfected some of their more spectacular effects, but I wasn't trusted just the same. I got away none too soon."

"But that was only a couple of years ago, sir, and here you are—"

"Commander in chief, you mean? I didn't join the revolution to get out of a hot spot, John; you know me better than that. I've been a brother since I was your age. I simply didn't go underground until I had to."

Colonel Huxley had been almost my only friend among the tactical officers and instructors on duty at West Point. He had encouraged my natural talent in those branches of physical science commonly called "miracles" because of their application in producing effects calculated to awe the ignorant masses. I recall now, looking back, that he had once tentatively advanced the thesis—in private conversation—that it might not be entirely wise to restrict the knowledge of natural law to the clergy and their servant arms, the army and navy; but I had defended the current arrangement so zealously, with arguments drawn from religious authority, that he had dropped the matter. I don't believe that he could have convinced me at that stage of my development. If one accepted the postulate that the Prophet had Divine guidance, the

justice of his temporal acts was a necessary corollary, and the logic of the system was airtight.

It was necessary first to shake my faith in the Prophet, then the rest of the system came tumbling down.

We chatted and reminisced at some length. It is good for a young man to have some older man whom he trusts and respects, and with whom he can talk seriously. It gives him confidence and prevents him from making too many callow mistakes.

"I didn't call you for the pleasure of seeing you alone, John," General Huxley finally said to me. "I have work for you to do. No doubt you have noticed the shortage of trained military men in our organization. Not only is there the natural excess of civilians over soldiers which prevails in any cross-section of society, such as the Brotherhood is, but also we make every possible effort to keep converts in the military class where we find them, in order that they may be effective when the time comes.

"But that leaves me short-handed in attempting to turn the Brotherhood into an efficient fighting machine. My personal staff, at present, are all civilian in background, hardly more than messengers and secretaries.

"Now I want you to act as my chief of staff—and my personnel adjutant, and my field adjutant, and my flag secretary, and my aid-de-camp. You won't be expected to walk the dog at night, nor to put the cat out, but aside from that you'll be 'the bos'n tight, and the midship-mite, and the crew of the captain's gig'! Will you do it?"

I stood up and answered: "Sir, I shall be honored to serve with the general to the best of my ability."

"Fine! You start at once. Move your gear to the apartment opposite my office. You'll find a bed of sorts

there—but you won't have any time to sleep anyhow."

And with a clap on the shoulder he sent me on my way, feeling rather dazed.

I HARDLY KNOW how to describe the next few weeks. The vast ramifications of the Cabal, which, up to this time, I had imperfectly sensed from seeing small portions piecemeal, were now spread out before me, and I spent the first few days in a frenzied attempt to assimilate the details.

The system of gigantic caverns called General Headquarters is located southeast of Phoenix, about thirty miles from the Mexican border. It had been in use for more than twenty years and had grown from a hideaway for fugitive brethren into a complete, modern military base. It had a dozen different entrances separated by miles of desert terrain, each entrance carefully concealed and protected by sensitive eye and ear devices and by automatic mines capable of destroying all trace of the tunnels that led to GHQ.

One outlet gave into the Mexican desert ten miles beyond the Mexican border. A passenger transtube of the progressive magnetic field type, and a little electric railroad for freight joined this outlet to GHQ through a series of tunnels both natural and artificial.

This entire area overlies a deep layer of late paleozoic limestone, and may well be honeycombed throughout. The area around GHQ had been explored only as needed. The areas in use gave promise of wonders yet to come. I was very keen to do a little amateur exploring, but the general said that he was not going to have me breaking my confounded neck while there was work to be

done, and forbade me to set foot off the lighted paths.

The temperature underground was fifty-nine degrees Fahrenheit, day and night, summer and winter, so that our living quarters and offices required heating. The air was pure and there was a plentiful supply of good spring water, quite hard, though suitable for drinking. Our supplies came in from Mexico, not only food and clothing and personal comforts, but electrical equipment, laboratory supplies, and a constant stream of vortex pistols, paralysis bombs, portable blasters, and small arms of every sort, which we transhipped to every part of the country.

GHQ was at this time a community of some eleven hundred persons, about eight hundred being men, the rest women. Theoretically it constituted a lodge, and a Grand Council of all lodges. In practice it was as near to a military organization as we could make it. The ancient forms of organization used by the fellowship since time immemorial were unsuited to the requirements of modern warfare. On any but the purely ceremonial occasions we dropped such titles as junior deacon, senior warden, and worshipful master, in favor of communications officer, supply and logistics officer, wing commander and the like.

And yet the normal organization



of an army was not exactly suited to the circumstances. We were forced to work with civilians, most of them totally untrained in military procedure, naïvely unaware of the principle of action under doctrine—the prime principle of all efficient military operation, the principle which harnesses obedience and initiative together into a working, co-operating team. Add to that the fact that the revolutionists were almost without exception strong individualists, usually of brilliant intelligence, and one can appreciate the difficulty of making disciplined soldiers of them. Yet had they not been as they were, they would not have been revolutionists.

Furthermore, the art of war is simplicity itself compared with the art of revolution. War follows well-defined principles, and analogies may be traced down through the centuries, whether the fighting is done with pilum and ballista, or with rocket and disintegrator; but each revolution is a law unto itself, a freak, a monstrosity, whose conditions may not be repeated.

XI.

THE Grand Council, consisting of the heads of departments, met weekly, or oftener, to exchange views and advise the commander in chief. It was part of my duties to be present at these meetings and record them by dictaphone and dictawriter.

One such meeting in particular deserves rather full reporting, because of its important consequences.

The usual routine reports were made; it was duly recorded that the total number of the brethren was eighty-seven hundred and nine active members, plus nearly ten times that many fellow travelers who could be counted on to rise against the

Prophet, but had not been intrusted with actual knowledge of the conspiracy. The communications chief reported that he was prepared to disable ninety-one percent of the television and radio stations in the country, and that with the aid of assault groups he could reasonably hope to account for the rest.

The chief of engineering—combat—reported his department ready to sabotage the power supply of forty-six of the largest cities, with the exception of New Jerusalem, which was completely self-contained. He reported further that he was prepared to interrupt service on the major surface transportation and freight routes sufficiently to reduce normal traffic by eighty-eight percent.

The reports droned on and on, and were very favorable. We had lost only seven operatives to the enemy in the past week; our own counter-espionage had apparently weeded out the weaknesses in our ranks. All indications were encouraging.

General Huxley received these reports with silent approval. I was phoning the data to the calculating room as it came in. There was a short wait while the data was correlated, then the ticker in front of me commenced to chatter. When it ceased, I tore off the tape and handed it to the general. He glanced at it, looked again, then cleared his throat and addressed them.

"Brethren," he began, "we agreed long ago on our course of procedure. When every predictable factor had been carefully estimated and assigned its proper weight, and when such a process showed that the probability lay in our favor by at least two to one we would strike. The solution of the probability equation, substituting this week's data for the variables, is two point one three. I

propose to set the hour of execution. How say you?"

At first there was dead silence—when men have waited too long for a thing, their power to believe in its realization is dulled—then they were on their feet, cheering, weeping, pounding each other on the back.

Huxley sat still during the demonstration, a quiet smile of satisfaction on his face. When the noise had died down a trifle, he got to his feet and raised his hand.

"I believe I can assume that you are all agreed," he commented dryly, "I will announce the time of execution before—"

But one of the council was on his feet, his face stern. "If you please, general. I do not agree." It was Colonel Novak, staff psychologist and chief of psychodynamics.

The ensuing silence fairly ached. If the cavern roof had fallen in, the council would have been less surprised.

General Huxley gave him the floor, saying: "It is rare for this council to act other than by unanimous consent. I had thought that we had already decided on the method of arriving at the date, in order not to strike prematurely. But you must have good reasons to object. Will you state them?"

NOVAK came slowly forward and faced the council.

"Brethren," he began, running his eyes over the indignant and bewildered faces, "you know that I would not lightly dissent. I raised my voice because of my deep conviction—no, more than that, the mathematical certainty—that we are not yet ready for the revolution. No, wait!" he went on, pushing a palm against a rising angry murmur, "I concede that all military preparations have been completed. I will even concede

that it is reasonably certain that we would win, and seize control of the country, if we struck now. Nevertheless, we are not ready to revolt, because the majority of the people still believe in the established religion, still believe in the Divine authority of the Prophet. We can seize power, but we cannot hold it!

"Remember, my brothers, no people was ever held long in subjugation save through their own consent. The American people have been conditioned from the cradle by the cleverest and most thorough psychotechnicians in the world to believe in and trust the dictatorship which rules them. Since the suppression of our ancient civil liberties during the lifetime of the first Prophet, only the most daring and individual minds have broken loose from the taboos and superstitions that were instilled in their subconscious minds. If you free them without adequate psychological preparation, like horses led from a burning barn, they will return to their accustomed place. The revolution may be short and successful, but it will be followed by a long and bloody civil war."

He paused, and ran a trembling hand across his eyes, glanced toward Huxley, and added in a low tone: "That is all I have to say."

Several of the members of the council were on their feet at once. Huxley pounded his gavel, and recognized Colonel Penoyer, chief of ordinance.

"If the master permits, I wish to ask Brother Novak a few questions." "Go ahead."

"Has his department accumulated sufficient data to tell us what percentage of the population is sincerely devout?"

Zebadiah, not himself a member of the council but present to assist his chief with reports, looked up. On

a nod from Novak he answered. "Seventy-two percent, plus or minus three percent."

"And the percentage of those who secretly oppose the government?"

"Thirteen percent, same limits. The balance can be classed as conformists, to whom present conditions are at least tolerable."

"By what means were the data obtained?"

"Surprise hypnosis of representative types."

"And what is the trend?"

"The government lost ground rapidly during the first two years of the present depression. Then the curve flattened out for a period of eighteen months. The new tithing decree was very unpopular, as was the vagrancy act to a lesser extent. The curve flattened again until our present propaganda program took hold. Since

then we have steadily gained ground."

"And what does the first derivative with respect to time show?"

Zebadiah seemed reluctant to answer this question. He turned to Novak, who answered in a strained voice: "It is necessary to take into account the second derivative as well as the first, as the rate is accelerated. If the present trend continues, it will be three years and eight months before I could give approval to military action."

Penoyer turned back to Huxley. "I have my answer, sir. With all due respect to the opinions and the careful scientific work of my brother, Novak, I say to win while we can; we may never have the chance again."

A wave of approval passed through the gathering: "Penoyer is right. If we wait, we may be betrayed." "Win

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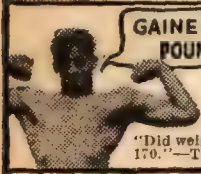
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first, and worry about making converts after we control communications." "I've been underground ten years; I don't want to be buried here."

General Huxley listened to the somewhat disorderly remarks with an impassive face, and made no attempt to quell them until cries of "Question! Question!" became insistent. Then he rapped for order. I had noticed that Zebadiah was whispering to Novak, who listened attentively, doubt in his face. Then he nodded to Zeb, who hurried up to the rostrum, and plucked at Huxley's sleeve.

Zeb talked earnestly for some moments in a voice too low to catch. I saw the same change in expression on Huxley's face that had taken place with Novak. Finally the general faced the council again.

"Colonel Novak has proposed a scheme which may change the whole situation. The council is recessed until tomorrow."

COLONEL NOVAK's plan—or perhaps I should say Zebadiah's, though he would never admit authorship—required a delay of nearly six weeks, it being necessary to wait for the annual miracle of the incarnation. Readers of a later day may not comprehend how important this festival was to the established religion. It is necessary to realize that the people really believed that the First Prophet actually returned to his people in the flesh each year to judge the stewardship of his successor. I had believed it all my life until I joined the Cabal, and I am a well-educated man. It had never occurred to me to doubt such a basic article of faith.

On the eve of the miracle we were gathered in the main communications room—Huxley, myself, Novak, Zeb, the communications officer, and his technical crew. The underground village was practically deserted, all

that busy throng having been transferred to their battle stations. There remained just those of us who had no battle stations involving combat during this phase. And there was nothing to do; the matters of strategy had all been settled long since, the tactical decisions could not be made for a whole continent from a single headquarters, and Huxley was too good a general to try. There was nothing to do but wait—and pray. We had finished sowing the seed, but we had yet to see what the harvest would be.

Our eyes were concentrated on a television screen which filled much of one wall of the compartment. The scene was the great hall of the temple at New Jerusalem. The scene was stereoscopic and in full color. The services leading up to the miracle had been in progress for some hours; processional, recessional, prayers, chanting, endless monotony of colorful ceremony. My old regiment, the Angels of the Lord, was drawn up in two rigid ranks, helmets shining, spears aligned like the teeth of a comb.

I made out Peter, master of our home lodge, motionless before his platoon. I pointed him out to Zeb. "You say he stole the film," I inquired, making useless conversation to ease the tension.

"Borrowed it, rather, and made a print."

"I wonder how he did it."

"I don't know. I'll bet Maggie had a finger in it."

On the other three walls of the room were a dozen or more smaller screens, showing scenes in as many major cities; throngs in temples, crowds in public squares, the Hollywood Bowl jam-packed. In each case the eyes of the crowd were riveted on a giant television screen on which was reproduced in minute detail the

scene at New Jerusalem. Throughout the country I knew it to be the same—every mortal soul who could possibly manage it was standing before some television screen, waiting, waiting for the miracle of the incarnation.

Zeb dug me in the ribs, and I looked back at the main screen. "It's coming," he whispered. The scene panned up to the far end of the temple, passed over the altar, and settled in closeup on an ivory archway above and behind the altar—the entrance to the Sanctum Sanctorum. It was closed with heavy velvet drapes.

After an interminable wait the curtains stirred, and parted. There before us, so real one felt he could step out of the frame, stood the Prophet Incarnate!

Behind me I heard the stir of the communications technicians swinging into their duties, low-voiced reports of "Rolling!" "In synch!" and then the communications officer's report to General Huxley:

"Synchronized with New Jerusalem, sir."

But I had eyes entirely for the Prophet, that powerfully, totally unscrupulous face, that magnetic gaze. Zeb spoke again: "We can take over any time now."

"Do you mean that you can duplicate *that*?"

"To the millimeter, or I'll eat the difference. Our best impersonator, teamed with our most skillful plastic surgeon."

The Prophet had completed his opening prayer, and launched into his blessing of the people. That completed, he paused and rolled his eyes up to heaven. Then commenced the petition to the First Prophet to confer upon his people the priceless bounty of seeing and hearing him in the flesh, and offering the flesh of

the present Prophet as an instrument for the purpose.

The first stage of the transformation took me by surprise; I was so taken in by the apparent reality of the scene that I forgot momentarily that I was not watching a projection of a real person, but in fact a re-broadcast of a triumph of trick cinematography, chicanery, in short—a fraud from start to finish.

The features of this living shadow commenced to flow. It grew an inch or two in height. Then the familiar features of the long-dead First Prophet took shape, the Prophet's robes melted into a frock coat of ancient cut, and there before me glowered the Reverend Nehemiah Scudder, erstwhile itinerant preacher in the Mississippi Valley before his epileptic seizures convinced him he was the Voice of God, and was thereby led into politics.

"Here we go," said Zeb. "We are about to take over."

THE IMAGE on the screen flickered for a split second and an arc flared behind me. If our timing was right, the government's network of telecasters were all out of commission, and our own network, strung just behind the Mexican border, were serving in their places. A quick inspection of the dozen smaller screens assured us of success. Our telecasts were coming through; the crowds were quiet; there had been no hitch. I started breathing again.

I breathed a prayer for the brethren who had sabotaged the telecasting stations; I was reasonably sure that they were all dead by now.

I missed the first few words that our synthetic First Prophet spoke; I suppose it was the usual greeting and expression of love and concern for his people. The first that I caught of his words was a diatribe against

sin in all its forms. Then he got to the meat of the matter.

"But I did not return to you this day to speak of the little sins of little people. No! I came to tell you of a much more hellish thing, and to bid you to gird on your armor and fight it. Armageddon is upon you! Rise up, mine hosts, and fight you the battle of the Lord! For Satan is upon you! He is here! Here tonight! With the guile of the serpent he has come among you, taking on the form of the Vicar of the Lord! Yea! He has disguised himself falsely, taken on the shape of the *Prophet Incarnate!*"

"Smite him! Destroy him!"

The revolution had commenced.

XII.

I CAN'T TELL very much about the first stage of the revolution because I saw only what came over the televisors. And that was very confusing. Rioting, inchoate mobs, about describes it. Friend was indistinguishable from foe in the telecast projections. Fighting there was—fighting everywhere, but whether our brethren won or lost we could not tell. In the Hollywood Bowl the audience boiled up over the rostrum and by sheer weight tramped down the officials and clergy on the stage. Now that shouldn't have happened from a technical, military standpoint—there were plenty of guards located at points of vantage to enfilade the charging mob before it swarmed over the footlights.

But, instead of the murderous, raking fire that one might reasonably have expected, there was one short blast from a tripod mounted on the hillside west of the stage, then the operator was shot—apparently by another of the guards.

Apparently the tour de force of using the miracle to destroy faith in

the Prophet had succeeded beyond expectation. If the government forces were everywhere as disorganized by the telecast as they appeared to be at the Hollywood Bowl, the task was not one of fighting, but of consolidating an accomplished fact.

It was nearly an hour before we received many reports from the division commanders. We were fit to be tied—at least I was—before we knew anything definite.

Then Lucas reported from New Orleans:

HAVE TAKEN CONTROL OF CITY CENTER. MOP-UP SQUADS ARE SEIZING WARD POLICE STATIONS. FEDERAL GUARDS COMPLETELY DEMORALIZED HERE BY TELECAST. SPORADIC FIGHTING BROKE OUT AMONG THE GUARDS THEMSELVES. WE HAVE ENCOUNTERED LITTLE ORGANIZED RESISTANCE. I AM RE-ESTABLISHING ORDER UNDER MARTIAL LAW—LUCAS.

Shortly thereafter reports came pouring in: Kansas City, Detroit, Philadelphia, Denver, Boston, Minneapolis—all the major cities of the country. The reports varied, but told the same story; cutting their lines of communication, combined with the demoralizing effect of the synthetic prophet's call to revolt, had made of the government forces a head without a body, warring against itself. The strength of the Prophet had been founded on superstition and fraud; we had turned that superstition against him to destroy him.

Our problem was to restore order, rather than one of fighting. Our forces were concentrated in the major cities in order to seize and retain control of the lines of communication and power. The countryside and villages could wait. It might take weeks to establish a trustworthy provost in each remote township; meanwhile the present local authorities would have to struggle along

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somehow while the Cabal, figuratively speaking, held a gun at their heads.

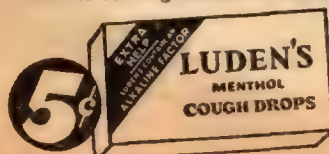
SIX WEEKS after the *coup d'état* we were established in St. Louis, provisional capital of the insurgent government. We had accomplished a great deal; there remained as much to do. We held the country, yes, but New Jerusalem remained intact, apparently impregnable, a living threat to our tenure. Worse than that, we were working against time with respect to the people themselves.

A fraud, such as we had used in the miracle telecast, has a temporary effect—people tend to revert to their former habits of thought. And the Prophet and his colleagues were not fools, far from it—they included some of the shrewdest mob psychologists this old globe has ever seen. Our own counterespionage made us uneasily aware that they were gradually perfecting an underground organization throughout the country. There was a large minority in the population who, forgetting for the moment theological considerations, had profited under the rule of the Prophet, and wanted him back.

Such people were being organized for the counterrevolution. They were the disseminators of a whispering campaign which exposed, pretty ef-

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fectively, the fraud that we had practiced on the people. That our fraud implied a previous series of frauds on the part of the Prophet did not reduce the effectiveness of the whispering campaign—people are inclined to believe what they want to believe, and they wanted to believe in the cult they had been brought up on.

If we could capture New Jerusalem, there would then be time and opportunity to change the psychological conditioning of the people and make them aware that they really had been saved from a tyranny which had ruled by keeping them in ignorance, their minds chained.

The plan concocted by Colonel Novak and Zebadiah provided for readjusting the people to freedom of thought and freedom of action. They planned nothing less than mass re-orientation under hypnosis. The technique was simple, as simple as works of genius usually are. They had prepared a film which was a mixture of history, theological criticism, simple course in general science, exposition of the philosophy of the scientific viewpoint and frame of mind, and so forth. Taken consciously, it was too much to soak up in one dose, but they planned to use it on subjects in a state of light hypnosis.

They had tried out the technique during the weeks before the miracle. Usually it had worked, and the subjects were semantically readjusted to a modern nondogmatic viewpoint, but if the subject was too old mentally, if his thought processes were too thoroughly canalized, it sometimes destroyed one set of evaluations without providing him with a new set. The subject might come out of the hypnosis with an overpowering sense of insecurity which usually degenerated into schizo-

phrenia, involute melancholia, or other psychoses involving loss of cortical control and consequent thalamic and subthalamic anarchy.

You can see that we had our work cut out for us, and that we did not dare hurry. More than a hundred million persons had to be examined to see if they could stand up under quick re-orientation, then re-examined after treatment to see if they had been sufficiently readjusted. Until a man passed the second examination we could not afford to enfranchise him as a free citizen of a democratic state. We had to teach them to think for themselves, reject dogma, be suspicious of authority, tolerate difference of opinion, and make their own decisions—types of mental processes almost unknown in the United States for many generations.

We had our work cut out for us! We had to maintain some sort of martial law over half a continent, provide the people with reasonably efficient civil administration so that life and trade might go on, combat counterrevolutionary plots, organize and get on with the enormous, well-nigh impossible task of readjusting an entire people and, simultaneously with all this, we must plan and carry out an attack on New Jerusalem.

The factor of time favored the Prophet. Unless we attacked forthwith and won, the counterrevolution would wipe us out before we had time to free the people from their psychological slavery.

I WAS in the flagship during the attack on New Jerusalem. I had asked General Huxley for permission to pilot a rocket during the attack, but was turned down. "What for, John?" he asked. "This job isn't going to be won in the air; it's going to be won on the ground." He was right,

as usual. We had plenty of rockets, but a bare half dozen pilots who could be trusted—and spared. The Prophet had plenty of pilots, but we had destroyed his one rocket field early in the war and had kept it under fire to prevent reconditioning it. Our own small force would be used to keep his rockets grounded with none to spare for direct attack. Their use would be strategic rather than tactical.

Rockets are not well adapted to attack on fortified positions in any case. They can't carry enough payload for heavy bombing, and must travel at too high a speed for accurate bombing, too. They are principally useful for high-speed, long-range reconnaissance; protection of bombing helicopters against enemy rockets, and fighting among themselves for control of the air.

Nor could we use heavy bombing helicopters effectively. New Jerusalem had the finest anti-aircraft battery in the world; picking off slow-moving helicopters would be like shooting sitting birds. We had plenty of pilots—any schoolboy can push a helicopter—but they must, perforce, bomb from high altitude, most inaccurately, and quit when our own forces had moved into the danger zone.

So I asked, not very hopefully, to be assigned to command a company of shock troops. Huxley bristled his eyebrows at me, and told me to tend to my knitting.

RENDEZVOUS was made on the east shore of the Delaware River. At one minute after midnight we moved east; thirty-four land cruisers, thirteen of them modern battle wagons, the rest light cruisers and obsolescent craft—all that was left of the Prophet's mighty East Mississippi fleet, the rest had been blown up by

their former commanders. The heavy battle wagons would be used to breach the walls, the lighter crafts would escort ten armored transports which carried the shock troops, five thousand of our best mixed militia—brethren and fellow-travelers, most of whom had had some military training in addition to what they had received in the last few weeks.

We could hear the bombing at New Jerusalem as we started out, the dull *hooHOOOM!* the goose-flesh shiver of the concussion wave, and bass rumble of the ground-carried sonic wave. The noise was almost continuous, and my mind unconsciously associated the sounds I heard with the concussions I felt, forgetting that the concussion wave reached us a good two minutes before the sound. It gave me an eerie feeling that we were already joined in battle.

The bombing had been going on for thirty-six hours; we believed that no one in New Jerusalem had been able to sleep the last two nights. On the other hand, all of us had had twelve hours enforced sleep just before the attack. In any case, the continuous bombing must have softened them up a bit, and destroyed some of their armament.

None of the battle wagons had been designed for flagships. We had improvised a flag-plotting room in the communications room just abaft the conning tower, tearing out the long-range televisior to make room for the battle tracker and concentration plot. I was sweating over my jury-rigged tracker, hoping to heaven that the makeshift shock absorbers would be sufficient to cushion the concussion when we opened up. Crowded in behind me was the psychotechnician and his crew of "sensitives," eight women and a neurotic fourteen-year-old boy. If it became

necessary, each one must attempt to handle four channels. I wondered if they could do it. One thin blond girl had a dry recurrent cough and a big red thyroid patch on her throat.

We lumbered along in approach zigzag. Huxley wandered from con to plot and back again, apparently calm as a snail, glancing over my shoulder from time to time, reading dispatches casually, watching the progress of the approach on the tele-screens.

The pile of dispatches near my elbow grew. The *Cherub* had fouled her starboard tread; she had dropped out of formation and would rejoin in thirty minutes. Penoyer reported his columns extended, and ready to deploy. Because of the shortage of command talent, we were using broad command organization; Penoyer commanded the left wing and his own battle wagon, Huxley was force commander, right wing commander, and skipper of his own flagship.

At 12:32 the televisors went out. The enemy had analyzed our frequency variation pattern, matched us and blown every tube in the circuit. It's not supposed to be theoretically possible, but they did it. Radio went out at 12:37, jammed and then blown.

Huxley didn't seem perturbed. "Shift to light-phone circuits," was all he said. "Keep contact in formation with sonics."

The communications officer had anticipated him. He hooked us up via telephone, using infrared beams for the ship-to-ship circuits. Bi-aural sonic range-finders kept the formation intact, each craft sending out its own sonic frequency.

Huxley hung over my shoulder for most of the next hour, watching the position plot lines grow. Presently he said: "I think we'll deploy now, John. Some of those pilots aren't any too steady; I want to give them time to settle down in positions be-

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fore anything more happens."

I passed on the order, and cut my tracker out of the circuit for fifteen minutes. It wasn't built to handle so many variables at such high speeds, and there was no sense in overloading the relays. Nineteen minutes later the last transport had checked in by phone; I made a preliminary setup on the tracker, threw the starting switch and let the correction data come in. For a couple of minutes I was very busy balancing the data, hands moving swiftly among the keys and knobs; then the integrators took hold with a satisfying hum, and I reported: "Tracking, sir!"

Huxley leaned over my shoulder. The line was a little ragged, but I was proud of them just the same—some of those pilots had been freighter jacks not four weeks before.

At three a. m. we made the precautionary signal, "Coming on the range," and our own turret rumbled as they loaded it.

At 3:31 Huxley gave the command: "Concentration Plan III; open fire."

OUR OWN big fellow let go. The first shot shook loose a lot of dust, and made my eyes water. The craft rolled back on her treads to the recoil, and I nearly fell out of my saddle. I had never ridden one of the new booster guns before, and hadn't expected the long recoil.

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them. Thus these booster charges maintain maximum pressure on the base of the shell right up to the time it leaves the muzzle, giving it an enormous muzzle velocity and terrific striking power—and a terrific recoil as well!

Huxley was at the periscope between shots trying to watch the effect of the fire. New Jerusalem had answered our fire, but as yet they did not have us ranged. We had the advantage of firing at a stationary target whose range we knew to a millimeter. On the other hand, even a heavy land cruiser couldn't show the armor that surrounded the palace.

Huxley turned away from the scope and remarked: "Smoke, John."

I turned to the communications officer. "Stand by, sensitives; all craft!"

The order never got through. Even as I gave it, the communications officer reported loss of contact. Telephone circuits using infrared-beam transmission are very fine things, simple, secret, and don't get out of order, but a thick cloud of smoke will stop the beam. But the psycho-technician was already busy, and I knew that the communications officers of the other craft would also shift to psycho without orders—it was normal casualty doctrine.

Of our nine sensitives, three—the boy and two women—were wide-awakes, the other six women were hypnos. The technician hooked the boy in first to Penoyer. The kid established rapport almost at once, and Penoyer got through a report:

BLANKETED BY SMOKE. HAVE
SHIFTED LEFT WING TO PSYCHO.
WHAT HOOK UP? PENOYER.

I answered: "Pass down the line."
Doctrine called for two different

types of telepathic hookup; relay, in which each craft relays messages down the line; and full mesh, in which there is direct hookup down the full chain of command plus hookup between adjacent units in the battle line. In the first case, each sensitive carries just one circuit; that is to say, he is in rapport with just one other sensitive. In the second case, my sensitives would have to handle as many as four circuits each; I didn't want to put such an overload on them until I had to.

The technician tied the other two wide-awakes into the two adjacent craft on the right and left flanks, and turned his attention to the hypnos. Four of them required hypodermics, the other two went under at once in response to suggestion. Shortly we were hooked up with the transports and second-line craft, as well as with the bombers and the rocket assigned to spot the fall of shot. The rocket reported that smoke had reduced visibility to zero. I told him to stand by, as a favorable sea breeze at sunup might make him useful again.

We weren't very dependent on direct observation in any case. We knew to an inch the geographical location of every angle and surface of our objective. We had made our departure with reference to the nearest benchmark of the geodetic survey, and had performed accurate triangulation up to the time the televisors blew. Thereafter we checked our dead reckoning by means of the data given by the sonic range-finders. That is to say that we knew our positions relative to each other; therefore, whenever any craft in formation had an opportunity to fix its position with reference to the ground by recognizing a building, bridge, or other fixed point, every other craft would immediately know its own ex-

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act position relative to every point in New Jerusalem.

Even after the sonics failed, we were well enough off. The dead reckoners of a tread-driven cruiser are surprisingly accurate. It's like this—every time the tread lays down it measures the ground it passes over. A little differential gadget to compare the speeds of the port and starboard treads, another gadget to do vector sums, and a gyro compass hook-in, to check and correct the vector addition, and you have a dead reckoner that will trace your course over fifteen miles of rough terrain and tell within a yard where you have ended up.

SHOT WAS FALLING all around us. Although the flagship hadn't been hit as yet we could feel the concussion when shells struck near us, and some of the reports were disquieting. Penoyer reported that the *Martyr* had been hit, rupturing the starboard engine room. The skipper had tried to cross-connect and proceed at half speed, but the gear train was jammed; she was definitely out of action. The *Archangel* had overheated her gun. She was still in formation, but would be harmless until the turret captain got her straightened out.

Huxley ordered them to shift to Formation E, a plan which used varying speeds and apparently random courses for each unit in the battle line. It was intended to confuse the fire control of the enemy by making his firing data obsolete before the shells left the guns.

At 4:11 Huxley sent the bombers back to base. We were inside the city limits of New Jerusalem itself, and the walls of the palace itself lay just beyond the city.

At 4:17 we were struck. The port upper tread casing was split, the barbette was damaged so that the

gun could no longer be trained, and the conning tower was cracked along its port after surface. The pilot was killed at his controls.

I helped the technician seal gas helmets over the heads of the hypnos. Huxley picked himself off the floor plates, sealed his own helmet, and studied the setup shown by my battle tracker, frozen at the conditions of the instant the shell hit us.

"The *Benison* should pass through this point in three minutes, John. Tell them to proceed dead slow, come alongside, and pick us up. Tell Penoyer I am shifting my flag."

We made the transfer without mishap: Huxley, myself, the psycho-technician, and his sensitives. One sensitive was dead, killed by a flying splinter. One other went into a deep trance, and we could not rouse her. We left her in the disabled battle wagon.

I had torn off the current plot from my tracker and brought it along. It had on it the predicted positions for Formation E. We would have to struggle along with those—the tracker couldn't be moved, and was probably damaged beyond repair in any case. Huxley studied the chart.

"Shift to full communication mesh, John. I plan to assault shortly."

I helped the technician get his circuits straightened out. By dropping the *Martyr* out entirely, and by using "pass-down-the-line" on Penoyer's left-wing auxiliaries, we made up for the loss of the two sensitives. All of them carried four circuits now, except the boy, who carried five, and the girl with the cough, who had six. The technician was worried but there was nothing to be done about it.

I turned back to General Huxley. He had seated himself. At first I thought he was deep in thought, then that he was asleep. It was not until I tried to rouse him that I noticed

blood seeping down the support column of his chair, and spreading over the floor plates. I moved him gently and found, sticking between his ribs near his spine, a splinter of metal. He had been wounded but hadn't shown it.

I FELT a touch at my sleeve. It was the technician. "Penoyer reports that he will be within assault radius in four minutes. Requests permission to change formation, and asks time of execution."

Huxley was out. Dead, or wounded, he would not fight *this* battle. By all proper rules, command devolved on Penoyer, and I should tell him so. But time was short, it involved a changed setup, and we had been forced to send Penoyer into battle with only three sensitives. It was a physical impossibility.

What should I do? Turn command over to the skipper of the *Benison*? I knew the man, stolid, unimaginative, a gunner by disposition. He was not even in the conning tower, but was fighting his ship from the fire-control station in the turret. Suppose I called him down; he would take many minutes to comprehend the situation—then give the wrong orders!

With Huxley out I had not an ounce of real authority. Should I turn command over to Penoyer—and lose the battle with proper military formality? Or rather, *what would Huxley have me do, if he could make the decision?*

How fast can a man think? It seems to me that I worried with the problem for an hour or more. The chronograph showed thirteen seconds between Penoyer's dispatch and my answer.

"Change formation at will. Stand by for execution signal in six minutes."

I shifted the right wing to assault echelon, and called the transport *Sweet Chariot*: "Sub-plan D; leave formation and proceed on duty assigned." The technician eyed me, but transmitted my orders. Sub-plan D called for five hundred light infantry to enter the palace through the basement of the department store which had concealed the local Cabal headquarters. They would proceed through the tunnels, coming out through the lodge room, and then break into squads and sections, each with an assigned task. All of our shock troops had every detail of the palace graven into their brains; these five hundred had received additional drill as to just where they were to go and what they were to do.

Most of them would be killed, but they should be able to create confusion among the defenders during the assault. Zebadiah had trained, and now commanded, them.

WE were ready. "All units; stand by to assault! Right wing, outer flank of right bastion. Left wing, outer flank of left bastion. Zigzag emergency full speed until within assault distance. Deploy for full concentration fire; one salvo, and assault. Stand by to execute. Acknowledge."

The acknowledgments were coming in, and I was watching my chronometer preparatory to giving the command of execution, when the boy sensitive broke off in the middle of a report, and shook himself. The technician grabbed the kid's wrist and felt for his pulse. The boy pulled away.

"Somebody new," he said, "I don't quite get it." Then he commenced in a singsong: "To commanding general from Lodge Master Peter: Assault center bastion with full force. I will create a diversion."

"Why the center?" I asked.

"It is much more damaged."

If this were authentic information, it was important. But I was suspicious. If, by any chance, Master Peter had been detected, it was an obvious sort of a trap. And I didn't see how he had found opportunity to set up communication by sensitive in the midst of battle.

"Give me the word," I said.

"Nay, you give me."

"Nay, I will not."

"I will spell it, or halve it."

"Spell it, then."

We did so. I was satisfied. "Cancel last signal. Heavy cruisers assault center bastion, left wing to left flank, right wing to right flank. Odd-numbered auxiliaries make diversion assaults on right and left bastions. Even numbers remain with transports. Acknowledge."

Nineteen seconds later I gave the command to execute, and we were off. It was like riding a rocket with a dirty, overheated firing chamber. We crashed through walls of masonry, lurched sickeningly on the turns, almost overturned when we crashed into the basement of some large demolished building, and lumbered out again. It was out of my hands now, up to each skipper.

As we slewed into firing position, I saw the technician peeling back the boy's eyelids. "I'm afraid he's gone," he said, in a toneless voice. "I had to overload him too much on that last hookup. Two more of the women had collapsed."

Our big gun cut loose with its last round, we waited for an interminable period—all of two minutes, it must have been—then we were moving, gathering speed as we rolled. The *Benison* hit the wall with a blow that I thought would wreck her, but she did not mount. But the pilot

had his forward hydraulic jacks down as soon as we hit, and her bow reared slowly up. We reached an angle so steep that it seemed she must turn turtle, then the treads took hold, we ground forward, and slid through the breach in the wall.

Our gun spoke up, fired at point-blank range, right into the inner palace. An idle thought flashed through my head—this was the exact spot where I had first laid eyes on Judith, four months—no, an eternity—ago.

The *Benison* was rampaging around, destroying by her very weight. I waited until the last cruiser had had time to enter, then gave the order: "Transports, assault." That done, I called Penoyer, informed him that Huxley was wounded and that he was now in command.

I was all through. I didn't even have a job, a battle station. The battle surged around me, but I was not of it—I, who two minutes before had been in usurped command of the battle line.

I scrambled up to the fire control tower in the turret, and peered out through the after slits. A breeze had sprung up at dawn, and the smoke was not so thick. The transport *Jacob's Ladder* was just pulling out of the breach. Her sides fell away and ranks of infantry sprang out, blasters blazing. A sporadic fire answered them. Some fell, but most of them charged the inner palace. The *Jacob's Ladder* cleared the breach, and the *Ark* took her place.

The troops' commander in the *Ark* had orders to take the Prophet alive. I hurried down the ladders from the turret, ran down the passageway between the engine rooms, and located the escape hatch in the floor plates, clear at the stern of the *Benison*. Somehow I got it unclamped, swung up the hatch cover, and stuck my head down. I could see men running, out beyond the treads. I

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dropped to the ground and scrambled after them.

They were the men from the *Ark*, right enough. I attached myself to a platoon leader, and trotted along with them. We swarmed into the inner palace. But the battle was over. We encountered no organized resistance. The inner door to the Prophet's quarters was open.

We did not arrest him. The Virgins had gotten there first; they left barely something to identify at an inquest.

A PROLOGUE AT THE END

MASTER PETER asked me to write this account. "John," he told me, "somebody who isn't a psychologist should tell this story so that our descendants will understand what happened and how the people felt from the viewpoint of the common man. You were in the thick of it—why don't you do it?"

Well, here it is. You can read the histories to find out how we lost our civil liberties; this is how we got them back.

Novak told me once: "There isn't anything wrong with the minds of the American people; they just suffer from a tendency to sell their birthright of freedom for a mess of pottage. Each one values liberty for himself but he is naively certain that his poor benighted brother needs protection. So we pass a lot of sumptuary legislation intended to protect the moral and spiritual welfare of our poor weak brethren. When it is too late, we find that in so doing we have surrendered our ancient liberties to a bureaucracy which tyrannizes us under the guise of protecting our souls.

"The American people have gone through this process to a lesser degree many times. Fortunately only this once did we so completely surrender our liberties as to require revolution in order to regain them.

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"The rapid development of psychodynamics in the twentieth century; the perfection of the techniques of advertising and propaganda; the spread of the pernicious principle of 'ideological' education—that is to say, catching children when they are young and telling them the same thing over and over again until their nervous systems are canalized and they are no longer able to exercise independent judgment concerning the subjects in which they have been so instructed—plus the development of radio, television, and other means of influencing masses of people simultaneously; all these things made the American people ripe for slavery—slavery to an idea.

"What we have to do now is to restore all the old civil liberties, plus a steel-clad, air-tight new civil liberty, one which will prevent dogmatic notions of every sort from being made into law. Especially we must avoid teaching dogma to children. We must teach our children always to doubt their elders, and to judge for themselves—on evidence, not authority!

"There need not be any conflict between science and religion. Science is concerned exclusively with natural phenomena, the physical universe, whereas religion is a personal matter between each man and his God. Men seek God by many paths, and

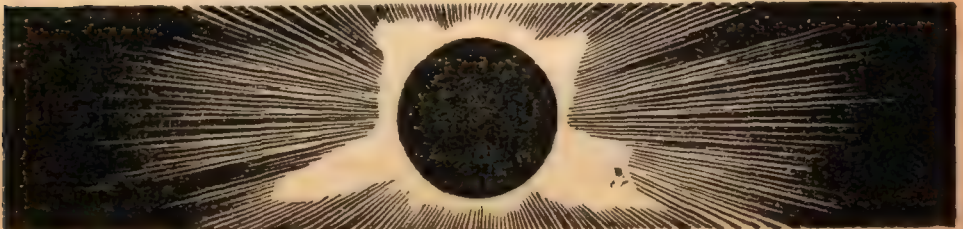
under many names. The best that government can do is to insure his right to seek his own path, and to guard vigilantly against any encroachment of religious liberty, even though the encroachment may be slight and urged from the best of intentions by our best citizens for the highest of moral reasons."

Which expresses it better than I can.

By the way, the boy sensitive who broke down during the attack on New Jerusalem recovered, but he isn't sensitive any more. The psychotherapists tell me that there is no lesion, but that he has a subconscious blockage, or fugue—his inner being has decided to have no more to do with such things. It's an odd business.

I WAS offered a job in the war department, with the rank of major, which Zeb urged me to accept, but I didn't. I found something that Judith and I like better. Reeves and I have formed a textile wholesaling firm; he's in the office and I'm in charge of sales. It suits me. I am minded of a quotation from Scripture that George Washington once used in describing the American ideal of freedom: "—everyone shall sit in safety under his own vine and figtree, and none shall make him afraid."

THE END.





BRASS TACKS

Our society is in the "civilize-the-newly-acquired-lands stage." The civilization of Smith's epic is in the same stage. They would be similar!

Dear Campbell:

Few of the readers of Astounding doubt that you, as editor, have dished us up the real McCoy. You have immeasurably raised the standard of writing; the stories have borne more and more "human" as opposed to "mechanical" interest; articles and stories alike have displayed accuracy and vision.

Nevertheless I shall confine myself in this letter to brickbats.

A man-sized grouse first of all.

You haven't a single author on your payroll at the moment who displays any real social insight. Briefly, you can do with some H. G. Wells or Olaf Stapledon to supplement your army of Vernes. T. C. McClary, DeWitt Miller and Don Stuart show a little of the quality I have in mind. That is all.

A criticism of E. E. Smith may illustrate my meaning. Smith writes superb blood-and-thunder, and he possesses a fine scientific imagination. Yet socially, the worlds of "Galaetic Patrol" and "Gray Lensman" are identical with our own.

This is totally unfeasible. With increasing knowledge of nature, and with changes in the way in which goods are produced, so also social relationships, laws and customs, must change.

Smith's interstellar communities could no more use our social forms than we can use those of the Amerindians.

Conversely, I submit that many developments mooted in Astounding predicate accompanying social changes, will never emerge without changed ways of living to bring them forth.

Examples?

"Space Flight." Industrial Atomic Power. The improvement of the human stock—knocking the Saps out of Homo Sapiens, as it were. None of these discoveries can be made as yet because as yet no social need for them is consciously experienced, and discoverers do not work in social vacuums.

In support of my arguments witness these facts: The steam engine was developed—not

invented—when expanding commerce created the need for it. Likewise modern preventive medicine came in with the growth of huge unhealthy towns. Firearms were developed in the same way, not by the obvious military users, the feudal knights, but by the new merchants of medieval cities. Early mathematics, again, originated along with astronomy to satisfy the needs of the first agricultural communities. And it changed the very fabric of those communities by developing priest-kings, who replaced the matriarchy common to primitive societies of hunters.

And so the interaction between old societies and new discoveries will produce changed social forms in the future. These changed forms will in turn act as the matrices of newer discoveries; still I make no statements as to the exact nature of the predicated changes. There is something for authors of Sprague de Camp's or Don Stuart's caliber to play with.

At least, we have here a fresh field of forecast and controversy. One which will transform the "great-scientist-determines-to-make-the-world-better-despite-itself" type of yarn into something at once more real, more useful, and what is equally important, more amusing.

I hope, by the way, that my bumptious challenge will bring forth Sir Smith: complete with lance and charger, as in days of yore. I am ready to join battle, if he is.

Minor grouses come under two headings. (A) Authors of whom I have had enough.

1. Jack Williamson. Mr. Williamson will still be using the "Green Girl plot in 1999, unless someone dissuades him.

2. Arthur J. Burks, who knows about as much of science as of humanity. And as for Josh McNab—he must have learned Scotch from a Shanggallander.

3. Warner Van Lorne. Gordelpus.

4. Kent Casey. College Humor, 2339 A. D.

(B) Authors of whom I have had far too little:

Don Stuart

Dr. Smith

Sprague de Camp

Dr. Clark

De Witt Miller

Robert "At the Perihelion" Wiley

Ross Rocklynne—when up to "Water for Mars" standard

T. C. McClary
Ray Garton (at his best)
Vic Phillips

My grouch seems to have evaporated. I can't close without a word of praise. The art work has improved steadily—the October cover in particular was a stunner. Carry on with the good work here.

You have made Astounding top number with such yarns as Stuart's "Forgetfulness," de Camp's fantasies and with all the articles.

My one wish is that you should find for us something as good as your own "Contest of the Planets," "Uncertainty," or Arcot Series—even though the conclusion of the latter, "Invaders from the Infinite," was too, too, cosmic. It has, I suspect, been the inspiration of such yarns as Smith's "Kinnison" stories, and Simak's "Cosmic Engineers."—J. E. Enever, B.A., 22 Cann Hall Road, Leytonstone, London, England.

Comet orbits may correspond to the reefs and rocks of mariners.

Dear Editor:

My voice to the multitude. Firstly, about the much condemned and much praised "General Swamp, C. I. C." I thought that it was great. Not tops, perhaps, but plenty good.

Asimov's recent "Trends" redeems him for me. Having dwelled in Holy Roller country in both Oklahoma and California, I can say that the boy knows whereof he preaches.

In the realm of *Unknown*, "None But Lucifer" manhandles you back to the "Sinister Barrier" level. Not that I haven't enjoyed most of your stories, except "Returned From Hell."

It seems to me that your space flight stories do not take into consideration the astronomical headache that comet orbits are cluttering up the other twelve months of the year. Maybe "Special Flight" will be a signpost. Maybe.

And why totally eclipse Dold? Sure his humans are lousy, but his machines make up for it. Jameson's article on space war-manuevers is excellent but really now, with rockets being what they will be, as he indicates the only direction for the avenging cruiser to approach would be from the rear. Since thermo-couples are impartial observers, would it not be embarrassing for the Martians to lay a field of mines for our hero? Firing angularly sideways would do the trick of laying them in his path at the right time if firing back would suspend them.

Smith's yarn is up to par.—Grady L. McMurtry, 104 Harkness Avenue, Pasadena, California.

—and some like it "Cold."

Dear Mr. Campbell:

"Gray Lensman" is, by all odds, the most forceful, impressive, and immense piece of science-fiction that has ever come to my attention. Only one story has ever surpassed it in strength of human characterization. It was "Who Goes There?" Only one story has ever surpassed it in field and scope of action, but "Cosmic Engineers" was sadly pale and wan compared to this. By no means the smallest share of the credit goes to Charles Schneeman, for his clear and cogent pen work, to Rogers for his "perfect cover" and, as Murray Lesser suggested, to the editor, for not slicing it to a mere ghost of its former self.

Contrariwise to the "Galactic Patrol" issues, only three of which had as much as one decent companion story, each of the last four issues was a credit to science-fiction in general.

The time has now come for a mild yelp, which I will summarize by saying that: isip's heroine for "Neutral Vessel" was unmistakably cross-eyed; the article was such a great big beautiful mess of formulas and stuff that I, hardy explorer that I usually am, passed it by with a shudder; and that "The Day of the Cold" just stunk.

Maybe that will help you improve a magazine that has already surpassed my fondest hopes, which really leaves very little more to say. Dick Wortman, Seattle, Washington.

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Read 'em? I certainly do. It's one of the things that makes editing interesting!

Dear Mr. Campbell:

The monthly report. (Do you really read 'em all?)

- | | |
|-----------------------|----|
| 1. "Gray Lensman" | A+ |
| 2. "Neutral Vessel" | B+ |
| 3. "Requiem" | B |
| 4. "The Smallest God" | B- |
| 5. "Moon of Delirium" | C |
| 6. "Day of the Cold" | C |

Article very good—a little technical, for a fiction magazine, perhaps, but I managed to digest most of it.

"Gray Lensman" ends in a blaze of glory. (I don't mean Nurse McDougall's hair, either!) There probably isn't anything left in the two Galaxies worthy of Kim's personal attention, but how about a novelette, say twenty thousand words, on a lone-hand adventure of Worzel on some bizarre planet of the Second Galaxy? No, I don't expect to get it.

"Neutral Vessel" is very good. The little personal glimpses add a lot to a fine story, which might possibly come true.

"Requiem"—another hit by Heinlein. I like his half-wonderful, half-pathetic characters; they are real people.

"The Smallest God" rates fourth, rather than higher, for two reasons—first, the high quality of the stories rated above it; and, second, because of the feeling that, perhaps, it isn't science-fiction at all, that perhaps it should have been in *Unknown*. I'm glad it wasn't, however, because I don't always read *Unknown*.

"Moon of Delirium" presents an interesting story of weird planetary menace, and a novel form of symbiosis. When the dog bites the man and the man is benefited by it, that's news!

"In the Day of the Cold" is grim, depressing, and realistic. What an end for our present half-baked civilization! Weston's little tales rarely rate tops, but they are always worth while. And incidentally, I've seen issues of science-fiction magazines with nothing so good as Weston's latest in the whole number.

The editorial is interesting and informative—it is always a fine feature.

Cover—well done, but it might appear on a trade publication. Much better, however, than a wild and woolly "adventure" scene. Enough! —D. B. Thompson, 3136 Q Street, Lincoln, Nebraska.

History and comments—

Dear Mr. Campbell:

Your first issue of 1940 has made me sad; the reason is that it contained the last and greatest chapter of Smith's "Gray Lensman." This has been the finest yarn I've seen printed in quite a long time, and now it's ended. I'm looking forward to your next two serials, "If This Goes On—" and "Final Blackout," and if they are as good as you say, they will be near the top for 1940. Now that the "Gray Lensman" is gone, I'm already looking forward to Smith's next yarn, which I understand is already started. Let's hope it's another "Gray Lensman."

"Neutral Vessel," by Harl Vincent, is my choice for second place. Vincent has made quite a comeback, and I sure hope to see more of him.

Schneeman's cover was fairly good this issue, though I like Rogers' covers better. In my opinion, you should use only Rogers and Wesso on Astounding's covers. Gilmore is not so hot. I was a little disappointed in Schneeman's drawings for the last chapter of Smith's yarn. Outside of the ones on pages 118 and 102, they were nothing more than a mess of lines that seem to have lost their way. The only other decent drawing—or should I say halfway-decent drawing?—is on page 81. The rest—well, you'd never know you were reading a science-fiction magazine by looking at them. Please do something about these drawings so that they have a little stiff atmosphere in them. My suggestion is to bring back Dold and use more of Wesso and have Schneeman change his style.

You have a good magazine, but you spoil it by those (censored) drawings.

Even if you and Street & Smith don't recognize it, your January, 1940, issue was the tenth anniversary issue of *Astounding*. Ten years ago, this month, there appeared on the stands the first small-size, unrimmed-edged science-fiction magazine, title *Astounding Stories of Super Science* and published by Clayton Publications. Since then the magazine changed its name to plain *Astounding Stories*, then back to *Astounding Stories of Super Science* and then Clayton went out of business. *Astounding* was taken over by S. & S., who put out its first issue in 1933, and the name was, a year ago, changed to *Astounding Science Fiction*. Ten years. Mr. Campbell. Ten years of *Astounding* and—we are going to celebrate. *Fantasy News* will do so by reproducing the January, 1940, issue on its January 7th issue, and the *Queens SFJ* will celebrate by seeing a scientific. Congrats on its tenth birthday, even if you don't celebrate it.—Jimmy Taurasi, Editor *Fantasy Times*, 137-07 Thirty-second Avenue, Flushing, New York.

Keep outa that cupboard!

Dear Mr. Campbell:

Item one: Rating of the January issue of *Astounding*. Last installment of "Gray Lensman" gets a big juicy cherry. Second and third installments were the best, I think, with first ranking last. "Neutral Vessel" gets a chewy nougat as Earl Vincent redeems himself in my eyes; Del Ray holds down third place with a cookie, and Hatcher takes fourth with a synthetic banana. As for the three shorts—they get the nuts and the razberries. Say, I think I oughta rank the editorial and readers' departments in above those stories. Department fifth, editorial sixth.

Item two: I like "Cover by Rogers."

Item three: I like R. Isip's women. His men, too.

Item four: Why isn't there more science-fiction poetry written? There has been lots of good weird and sheer fantasy poetical effort. You could help along a good cause by opening the pages of *Astounding* to science-fiction poetry. And I mean science-fiction poetry.

Best wishes for a great 1940.—Dale Tarr, 816 Elm, Cincinnati, Ohio.

The robot girl was Helen O'Loy—and del Rey wrote that, too!

Dear Mr. Campbell:

There was a whimsical touch to "The Smallest God" that I liked a lot. The little god was very human. The hope of finding such outstanding items is the only thing that keeps me reading the magazines of your field. This was as good as the other about the beautiful robot girl—I don't remember the title, but I certainly remember the story.

I read Smith's "Gray Lensman." It was a good job and I feel sure it would be of great interest to a new reader, but I am so familiar with the writer's plot form that I did not get near the kick out of this that I did "The Sky-lark of Space"—I believe that was the title.

I hope you have a most successful 1940.—W. A. Eubank, Andrews, North Carolina.

Van Vogt's coming up with another yarn of a different type.

Dear Mr. Campbell:

I'm sorry to do this, but I fear I must place on record my first major complaint in ages.

What in the name of great Klono's whiskers happened to Wesso? He's been getting less and less work for some time, and now he has vanished completely. Really, Mr. Campbell, I object! Despite certain incomprehensible opinions to the contrary, Wesso rates plenty high as an illustrator, and I'd hate to see him dropped altogether.

Analysis of the December issue:

1. "Gray Lensman"—tops, of course.

2. "Discord in Scarlet"—not quite up to Van Vogt's "Black Destroyer," probably because it was a little too much of a repeat on the former yarn. Very good, just the same.

3. "City of the Corporate Mind"—good. The series begins to pall a bit, though. Isn't it about time Schachner found his truly democratic race, if he's ever going to?

4. "Sculptors of Life."

5. "Thundering Peace."

6. "The Nova."

One final cheer—for the two-color illustrations. A pleasant surprise, indeed. I hope the experiment is a success and you can continue to use them.—A. Arthur Smith, Queen's University, Kingston, Ontario, Canada.

Question for readers:

Dear Mr. Campbell:

In the November issue of *Astounding*, one reader compliments my "Forces Must Balance," but dilutes it with: "I'm getting a little tired of petal-pussed Martians." It's up to me to offer explanations, and ask a question.

Explanation: For almost ten years I have been trying to visualize, in story after story, the Universe at and around the thirtieth century. Some of my science fiction has faltered away from this job, but not much of it. I have been able, in some degree, to round out (for myself, at least) a picture that not one story, or two, or five, could really give. For instance, there was a war in the twenty-eighth century between Earth and Mars that profited nothing but peace and understanding. Those who do me the favor to read my stuff may have noticed more than once the names of such Martian cities as Pulambar and Ekadome; my proposition that the Jovian satellites make up a government that sprang from an old Martio-Terrestrial colonial set-up; similarities from story to story in habits, weapons, space travel—yes, and in Martians. They're usually polypoid and flowery-headed, able to communicate with Terrestrials only with the aid of purring voice boxes. Almost sequels, such stories—but not quite. I seldom use the same hero twice. To me the thirtieth century has enough heroes so that they don't have to double up.

Question: Is this a good thing or a bad thing? Shall I delve ahead into this particular chunk of the future, trying to develop it, or shall I mix ideas henceforth—use, for instance, spideroid Martians in the next story, reptilian ones in the next thereafter, and so on? I'd appreciate your opinion, as well as that of any interested reader.—Manly Wade Wellman, Grant House, R. F. D. No. 1, Scotch Plains, N. J.

We hope they did get all the issues over there.

Dear Mr. Campbell:

Many thanks for printing my letter regarding the control of spaceships: it has resulted in several inquiries from readers and no doubt more will come in as the mail trickles through. I have been able to deal with all letters received so far, but I would like to apologize in advance to any readers who may not receive replies to their communications. The E. L. S. has now been carefully packed up in cold storage for the duration, and until the war is over we have stopped all active work. Most of our officers

have been scattered to the four winds or called up: I shall be going in a relatively short time now and so will not be in a position to answer any correspondence—even if it reached me safely.

When we get back again we will start the society going once more, and I'll drop you a line to that effect. Obviously a slight disturbance like the present civil war cannot be permitted to upset the conquest of space!

My best wishes for the future progress of Astounding. I sincerely hope that I can get hold of the rest of "Gray Lensman"!—Arthur C. Clarke, British Interplanetary Society, 88, Grays Inn Road, London, W. C. 1., England.

Maybe he didn't like that cover—

Dear Mr. Campbell:

Confidentially, the cover of the December Astounding stinks. But I suppose you realize that yourself. Let's have some Wesso and Cartier and a dash of Rogers. I like Koll for interiors, and his change of style in this issue makes one think that perhaps he actually has an imagination. Cartier is excellent, both for comic interiors and for covers. His *Unknown* opus is magnificent.

E. E. Smith is wonderful, of course. I wallow in the luxury of his cream-thick adjectives and in the relentless logic of his plotting. I love an author who writes so he sounds logical. But, alas, all illusions must fall, all hero worshipers must come to their doom, and so with heavy heart and weepy eyes I confess that I find quite a heavy dose of the common, bourgeois prude in Dr. Smith. Klunison has the possibilities of a magnificent character, but at the most he is only two-and-a-half dimensional. He never quite gets to the point of being three dimensional. He also irritates me by constantly leaving me a step or two behind his thoughts. He is completely extroverted. With him, to think is to act, with me trailing merrily behind, never knowing what is going on in his head. He is not personal enough. I think I rather prefer the introverted characters of Hubbard, de Camp, and Gold.

Nevertheless, it is a damn good story, and the amazing thing is how Smith manages to get so much material into one novel.

Two stories that I particularly liked in the December issue, in order: "Sculptors of Life," and "Discord in Scarlet." The first has the most real characters seen in a long time. They converse breezily, like people; they are sophisticated, never lose their heads; their hearts don't pound, their pulses don't beat, they don't go into hysterics every time the villain says "Boo." There isn't a trite word in the story. The social significance is real, the dictator business is kept in the background, whereas another author would have made it the main point of the story, and thus would have sold it to some other magazine. And the psychology at least sounds plausible.

The crimson story is lovely because it shows a group of real scientists who act like rational beings. Perhaps a bit too rational, but the circumstances must be considered.

For prophecy, Nat Schachner may not be so far from the truth. The world seems to be in the process of dividing itself into small groups with different purposes. I don't remember the time Schachner gives for his evolution, but it seems to me it would take a good many millenniums to arrive at his state of affairs. Another difficulty about long-range prophecy is the fact that trends reverse themselves so easily. The present wave of nationalism may be merely the prelude to world consolidation.

Science-fiction prophets put too much emphasis upon political and sociological aspects. They speak in terms of democracies and dictatorships and various forms of governments, when what actually determines events is economics. It is doubtful whether the present trends could continue very long without economic laws stepping in and shifting the balance. It is all very complicated. Makes me rather woozy.

I wish you could get more prophetic stories. They're as hard as the devil to write, and they are very ungrateful things, for in ten years you're liable to find that you were all wrong. But I started science fiction and continued to read it because I have an insatiable curiosity to know what life in the future will be like. Why not have some stories just depicting life in the future? I liked "Sculptors of Life" because it was so natural that way. The only requirement for a prophecy is that it sound like it might happen. And be fairly authentic according to economic laws. And above all, it must be a good story.—Milton A. Rothman, 2020 F, N. W., Washington, D. C.

Looks like more Wallace West would be desirable—

Dear Mr. Campbell:

Just a few lines to tell you how good Wallace West's "Sculptors of Life" is, and to give you my vote on the relative values of the stories in the December issue.

You'll understand how good it is when I tell you that I rated it first—thus putting it above Smith's "Gray Lensman"! By all means, let us have more from Wallace West. His story is a highlight in the year's brilliance.

Smith is still good, but he only gets second this time.

"The Nova" is good, but too short to have a chance. Let's have them longer.

"Discord in Scarlet" is fourth.

"Thundering Peace" is fifth, but very close to "Discord."

I'll say naught of Schachner's tale, but that I don't like it.

De Camp, as usual, is good.

Issue, as a whole, good.—Allan Ingvald Benson, 1417 N. 48th, Seattle, Wash.

Perfect stories?

Dear Mr. Campbell:

From time to time, privileged Brass Tackers have mentioned two or three stories of times past which loom like titans on their personal horizons. Since any such thing profits by being systematized, my list of Perfect Astounding Stories comes under the following headings:

1. A colossal production, pure and simple; "Twilight"—Stuart.
"Alas, All Thinking!"—Bates.
"Forgetfulness"—Stuart.
"Who Goes There?"—Stuart.
"Creak of Aesir"—Stuart.
"Sinister Barrier"—Russell (Astounding, regardless).
2. A clever, careful, logical piece of literature; "Old Faithful"—Gallun.
"The Mightiest Machine"—Campbell.
"The Machine" series—Stuart.
"At the Center of Gravity"—Rocklyne.
"Frontier of the Unknown"—Knight.
"The Master Shall Not Die!"—Miller.
"Other Tracks"—Sell. (What happened to him?)
"The Merman"—de Camp.
"The Morons"—Vincent.
"Heavy Planet"—Gregor.—Dick Wortman.

You've got your directions wrong, but Kim's already investigating a focus of trouble, I understand—

Dear Mr. Campbell:

Well, the incredible Gray Lensman is now through with his equally incredible adventures, and everything is well with Tellus and the Tellurian Galaxy, at least for some time to come. A lot has been written about our hero's physical

stamina, and some doubts have been expressed as to the possibilities thereof, with much of which I do fully agree, but I will let that pass. At any rate, it takes supermen and superwomen to overcome such contingencies, and, certainly, overcome them he did, and how!

But now, let us scrutinize another aspect of this narrative. It seems to me, when everything is boiled down to its primal elements, that it comes out as a contest between two distinct and entirely dissimilar cultures, each having reached its highest possible level of evolution, each in its own stellar system. No doubt, Eichen, speaking for Boskone, did not at all consider themselves evil. To them the whole universe was fair game, even as we are to a hungry tiger. But the Arisians, apparently, thought otherwise. Seemingly unconcerned as they appeared to be about anything except themselves, nevertheless, they deemed it appropriate to furnish the Tetrarians and others of our Galaxy with the necessary means to destroy completely the monstrous culture of Boskone. Now, did they do this for altruistic reasons only or was there also an element of their own comfort mixed in? I wonder. At any rate, I would like to see what the Arisians really can do, if they think that the occasion demands an extraordinary effort in their own behalf. Seems to me as if a thought wave did impinge upon my mind having something to do with some peculiar goings-on on the fifth brightest galaxy of the Virgo Cluster. Perhaps the Arisians are already onto it and are putting us on guard. Anyway, something very sinister is afoot in the center of the Virgo Cluster, seven million light years away, something more formidable than even the Boskone ever could be, and, apparently, the Arisians are aroused. Whatever it is, they know that it will tax their energy and ingenuity to the utmost to meet and deal with it when the time for action comes. Come on, now, Dr. Smith, and let us see what the highest intellectual forces evolved in our galaxy can accomplish when they have to. The Gray Lensman ought to be pretty well rested up by this time, and when he gets ready for his next flit, maybe he will give some of us a ride.

I have followed up the various sci-fi-fiction magazines since 1926 and find Astounding Stories on top of the heap. It has no superiors. I like the articles on pure science. I have shown them to some of my friends who accuse me of wasting my time reading useless fiction. And these friends have found it necessary to change their minds. You have experienced a great success in the past, and I do wish you an even greater success for the future. Arthur A. Johnson, 209 N. W. Sixth Ave., Portland, Oregon.

Long-term review.

Dear Editor:

Although this is my first attempt to write a letter to Brass Tacks, I have not missed more



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than two or three Astoundings since 1934. Though this letter will probably not see print, here are my opinions anyhow.

* indicates fair; ** good; *** better than average; **** exceptionally good; ***** well, there is no way to put it, except *best*—by parses—or something. These are only averages, since early in 1937.

Covers first, stories second, articles third, drawings fourth, et cetera.

Covers: ***** Schneeman. *** Brown, Wesso. ** Rogers, Gladney.

Stories:
***** E. E. Smith, Ph. D.
***** Jack Williamson, John Berryman.
**** Warner Van Lorne, J. D. Clark, Ph. D.; Kent Casey, C. D. Simak, L. S. de Camp, F. Engelhardt, M. Jameson.
**** Amelia R. Long, P. S. Miller, Harl Vincent, Nat Schachner, Don A. Stuart, M. W. Wellman, E. F. Russel & L. T. Johnson, Don Evans, Ross Rocklynne, Robert Willey, Eando Binder, Thornton Ayre.

**** N. R. Jones, A. B. L. MacFadyen, A. B. J. MacFadden, A. J. Burks, T. C. McHenry, N. S. Bond, Don Wire, A. E. Van Vogt, Vic Phillips, A. M. Phillips, E. K. Shoat, F. Cross, W. C. Beckett, K. B. Kruse, Harry Walton, L. R. Hubbard, Ray Cummings, F. A. Kummer, Jr.

Articles:
***** J. W. Campbell, Willey Ley, E. E. Smith, Ph. D.
**** M. Jameson, L. S. de Camp, Jack Hatcher.
**** Arthur McCann, P. Van Dresser, H. A. Lower.
**** R. deWitt Miller, Leo Vernon, H. C. McKay.

**** Battell Loomis.

Drawings:
***** Schneeman. He is the best of them all, human and other figures, scenery or spaceships, and planetary objects.

*** Orban, R. Isip, Binder. Binder is best for human figures and scenery, also for practical-looking machinery.

**** Koll, Wesso. Wesso is fine for imaginative machinery.

**** Dold. Dold is fine for angular objects, modernistic buildings, spaceships, if he is careful. But—never, never, for human figures.

Please! Never admit weird and unscientific stuff into our mag. By that I mean: "Wings of the Storm," "The Smallest God," and all the rest of the same unscientific nonsense. Never, never, never do that! When I see that type of story in our magazine I almost cry from shame. But if the same authors write something with a scientific base—O. K.

Let's have more stories like "Special Flight"; I also liked "The Morons," "General Swamp," C. I. C., "Cosmic Engineers," "The Last Hope," "The Cloak of Aesir," "The Return of Jason." All these and others need one or more sequels. What about it?

Keep up with the improvements. Why not add from ten to forty pages?

Before I forget, please do not leave out the articles at any time. And let's have more about Johnny, the educated Black Bear; he gives me a kick. Besides, we need more humor these days, anyhow.—Arvid E. A. Astad, 1211 Henry Street, Berkeley, California.

We've got something special in mind!

Dear Mr. Campbell:

The poor showing made by the December cover is, of course, deplorable, but need not happen again. But it did bring to the surface some random thoughts that I herewith present for editorial scrutiny.

After the forthcoming attack on Uranus, there will be left just four that can be done with any great deal of accuracy: Neptune, Venus, Luna, and Earth from the Moon. I may be very much mistaken, but I don't at present see how Pluto can be used for a cover. So little is known about the planet. However, on the other hand, some material may be found which will make possible a very good picture of one of Jupiter's moons. But that is secondary in importance to my forthcoming sug-

gestion. How about an astronomical cover of one of the more beautiful nebulae? Take the Great Nebula of Andromeda, for instance. Of course, it would have to be a photograph and would necessarily be only black and white, but with a little artistic ingenuity and "temperament" going into the make-up it could be made a strikingly beautiful and authentic astronomical cover. Any of the more outstanding nebulae, such as the Ring Nebula in Lyra or the Horse's Head Nebula, would, if done right, make superb covers. Naturally, that calls for a story by Williamson or Smith, but then why not?

Dr. Smith takes first place again and Schachner comes second; "Discord in Scarlet," third; "Sculptors of Life," fourth, and Kent Casey's little opus, fifth. This latest of Casey's is certainly not his best, but I enjoyed it and I say, "Thanks, Mr. Casey." Because De Camp's was an article I'm not going to displace any of the stories to give it a rating; but, in case you're interested, it rated second only to "Gray Lensman."

Naturally the two-color illustrations are very welcome.

As we go into another year all my best wishes are behind you and I have a double dime waiting for each issue of our magazine as it comes out.—Charles W. Jarvis, 2097 Iglehart Avenue, St. Paul, Minnesota.



SCIENCE DISCUSSIONS

I don't know—maybe McCann did look it up. Anyway, this is the answer.

Dear Editor:

I think I've solved Mr. McCann's little headache about the man who can't run into doors—or live—on a streamliner, but I'm curious now to know whether the problem was original with him, or actually the famous, but never-published old "mathematical proof that man could not live at speeds greater than 30 miles an hour"? Do you happen to know whether that was the original system of calculation? Or what the original was?

At any rate, the answer to his problem, I believe, lies in admitting that McCann's energy calculations are quite right. The man does have to dissipate 81,000 units of energy in slowing from 104 to 100 miles an hour if he runs into a door on the streamliner. It is equivalent—in energy dissipation—to running into a wall at some 28 miles an hour.

But it is *not* equivalent to running into a stone wall at 28 miles an hour; it's more like running into a highly elastic rubber wall. For, during the time the man is colliding with the streamliner's door, that door is moving, and moving rapidly. The kinetic energy is work, and work equals force times distance. If he is traveling 102 M.P.H. (average of before and after speeds) he's covering very nearly 150 feet a second. If it takes $\frac{1}{2}$ second for the collision with the door, the force of the collision acts, not through the apparent 1 or 2 inches of compression the man's chest (and perhaps nose) suffers, as it would if he walked into a door in a house, but through a distance as many times that as will exactly offset the additional speed. After all, stopping from a speed of 28 miles per hour in a distance of 75 feet would not be particularly drastic; neither is slowing from 104 to 100 miles an hour in that distance. And that distance must be taken into account.

The same applies, of course, to his acquisition of that energy when he starts walking along the train. He builds up that energy by exerting the force of his normal stride through a highly abnormal distance—more than 130 feet. It all works out. It would be a tougher world than it is if it didn't!—James Jones, 34 Boulevard des Italiens, Paris IX, France.

Well, we don't like a bunch of departments, but maybe a sub-department of Science Discussions. "Slip-stickers" sounds interesting.

Dear Mr. Campbell:

In view of the various cockeyed examples of logic gone ingrown published recently—notably Mr. Drew's Rythebootstrapsifter and McCann's man-killing-speed problem—I propose that ye olde ultramodern, Astounding, start a department of puzzles, science or science-fictional in nature, to be known, appropriately, it seems to me, as "The Slip-stickers." (For those not engineers, I'll add that a slide rule is familiarly—but not always lovingly—called a slip-stick.)

So—to start the ball rolling, here's a science-fiction puzzle. Tobias McDoodle, our young and ingenious hero, has invented a perfect transmutation machine in his home laboratory. It will transmute any material to any desired element with absolute 100% efficiency. If desired, it will produce electric power by destroying the material fed, instead of transmuting it, or, conversely, convert energy to matter. It's wonderful!

But, sadly, McDoodle has spent all his funds inventing it. It's patentable, of course; but, remember, a patent is simply a license to sue anybody that uses your process—which doesn't help much if you haven't any funds to sue with, and it's pretty obvious all the world and his uncle is going to start infringing wholesale. Somehow, then, McDoodle is going to have to make his gadget produce considerable wealth—say \$500,000—without revealing what he's got.

McDoodle is fortunate in one thing; he's got a friend who's a lawyer—er, that is, he will be in another two years if he passes his bar examinations. Phineas, the lawyer friend, gives some helpful advice at a critical moment—just after Tobias has transmuted six solid-plaster examples of mid-Victorian statuary Aunt Matilda gave him into solid gold. Phineas advises

strongly that he have a darned good story cooked up for the police when they come investigating the source of his suspicious and sudden wealth, or give up the manufacture of gold right then and there. Says Phineas: "You don't suppose, dimwit, that the police don't keep an eye on sudden acquisitions of gold, do you? And don't try platinum, silver, or anything like that, either. How about radium? That's expensive."

Tobias, scornfully eyeing his friend, sighs: "You think the world's radium isn't registered, gram by milligram? They'd trace that down in the twinkle of a spiathariscopes. No, I know—we'll find a treasure! That's it!"

"Ha!" says Phineas. "A buried treasure now. Why, man, you'd have to set up a mint and start minting pieces of eight or something to get away with that. Or organize an expedition to a South Sea Island. Huh-uh. No dough. Use imagination—something ingenious."

"I'll find a gold mine," says Tobias, worriedly. "Then call in government inspectors to check the gold output. That'd be too sweet a racket for fences—dealers in stolen goods—if it wasn't checked. You'll have to think out something that men with stolen goods haven't tried to use. Hasn't your widget some specialty? How about making this didymium and neodymium and stuff? Rare elements?"

"Yeah," growled Tobias. "I can make it by the pound. Who wants it when I've got it? By the pound, I mean. A couple of chemists who specialize in useless and cockeyed elements who'd like to see one all by itself, maybe. But that kind of chemist doesn't have half a million dollars. I want something I can sell and get big money for. I—"

"Whoops, boys! I've got it!"

Swiftly the daring young atomic physicist unfolded his ingenious plan.

O. K., slip-stickers! Let's see you fold it up again now! It must be a system which does not require any considerable investment, which will, within a reasonable time—say, a year—permit McDoodle to make a half-million dollar profit, and will not put him in a position which will force disclosure of his discovery. And which won't require him to handle tons of material—i. e., he might turn sand into graphite, but he'd need a good many tons to get anywhere, and his home-laboratory-scale production would rule that out.—Robert Tarrant, 131 Park Avenue, Hoboken, New Jersey.

A cyclotron would make an amusing gadget for the home experimenter—

Dear Mr. Campbell:

Having heard and read much about cyclotrons, and being near enough to New York and Columbia University's example of the genus, I finally worked my way up there. I was rather astounded at my total and complete failure to understand what a cyclotron was. Yes, I'd read enough to know that it was a merry-go-round for ions, with a radio-frequency potential applied to each ion many times as the particle went round and round to come out here. But I didn't appreciate the scale of the thing. For instance—the radio-frequency potential is supplied by a four-foot tall, six-inch thick, water-cooled, copper-jacketed transmitter tube with wallop enough to run an electric furnace!

A cyclotron is not the sort of thing devotees of the home workshop are apt to construct; in fact, it's the sort of thing so few workshops in the country are able to construct that something of what actually goes into one may be a bit of a puzzle. How they work in theory is fairly simple; how they are, in practice, made up is something vague to most that do know how they work.

Point A is, of course, that they cost money—money in rather large gobs—and that's always hard to get, anyway. Of course, the main

item is the magnet frame, a dainty bit of iron weighing from sixty to (proposed) two thousand tons. It's one huge and nicely machined chunk of solid metal, or at most a few pieces rigidly fixed together!

But first, briefly, the theory: In Fig. 1 is a representation of the magnet and magnet coils, for general understanding of outline. Fig. 2 shows the cyclotron chamber. A-A are the "D electrodes," so called for their shape. The coil filament in the center supplies the electrons which, by collision with atoms of gas in the nearly evacuated chamber, indirectly supply the ions of hydrogen (protons) or deuterium (for neutrons) as the case may be.

These ions are, of course, positively charged. The D electrodes are charged by a radio-frequency source of potential; whichever is negatively charged at the instant the positively charged ion is formed, attracts the ion. It falls toward it with enormous acceleration, rapidly—in millionths of a second—acquiring a velocity of miles a second.

But the entire chamber is placed between the poles of the huge magnet, and the magnetic field causes the moving electric charge to turn aside, resulting in a curving path, a curve that becomes less and less acute as the speed of the particle, and hence its centrifugal force, increases.

The particle reaches the negative D electrode—just in time to have the radio-frequency cycle reverse, making that electrode positive, and hence repulsive, and the opposite D electrode negative. Immediately the particle falls now toward the opposite electrode, its course constantly curved by the action of the magnetic field. It goes far faster across the gap between the electrodes this time, for, while there is a hundred-thousand-volt potential, perhaps, between the two D electrodes, it has now fallen through that potential twice, and has a two-hundred-thousand-volt speed. But—the magnetic field has curved its course less, too, because of that speed, so the curve it follows has greater radius, and longer circumference. The two effects—more rapid tracing of the course and lengthening course—in practice beautifully, neatly, and precisely cancel. The particle is gypped again. It's going faster, but still doesn't get over to that negative electrode quite quickly enough; the radio-frequency potential has been reversed again.

On round three it misses again.

Also on round four.

It never does reach one of those electrodes before the potential has escaped it—but eventually it acquires such an enormous velocity, and so terrific a voltage-equivalent energy, due to constant, repeated falls through that one-hundred-thousand-volt potential, that the magnetic field can no longer curve its path sufficiently to hold it within the circular area between the pole pieces. It escapes finally in a tangential path where its velocity and energy is used in whatever form of experiment is desired.

With these facts in mind, it becomes clear that there are two ways of increasing the final discharge voltage of the particles. There are more in practice, because theory is sweet as a dream, but, Lord, how sour the practice can be! The insulation between the D electrodes can break down. The necessary resonance may go wrong as the radio frequency gets out of step due to minor troubles. It also invents new troubles of its own that nobody thought of before.

But the two main ways of increasing the voltage discharge both have to do with holding the particles within the field of activity of the magnetic-pole-pieces longer, and hence where the reversing potential of the D electrodes can snap them around a few more times. This can be done in the obvious way—making the pole pieces larger—of course, but that means the cyclotron creeps up on you. First sixty tons, then two hundred tons, then two thousand tons of iron. The proposed two-thousand-ton cyclotron will have pole pieces of astronomical size—at least the size of astronomical telescope mirrors!

The other method is to make the magnetic

field more intense, which bends the path of the whirling particles into a tighter spiral, and crowds more turns-of-the-particle per inch of pole-piece diameter. That means more current in the magnet windings, which means more power, which means more heat—and more difficulties.

Such is theory. Now for practice. What does a cyclotron mean to the men who have to set it up?

First, they've got to get the magnet frame. Sixty or more tons of iron, shaped just so, transported to a usable place. The two originals belong to the United States navy, on loan to universities. Columbia's sixty-ton magnet was made in early World War I days. At that time the navy had the sound idea that it would be a wise policy to have our own radio-sending stations powerful enough to reach our ships, wherever they might be. The cyclotron started out to be a radio set!

It was in the pre-war days, and the pre-radio-tube days. The method then used for high-power sending sets was the spark transmitter, but turning on and off a high-energy spark wasn't a trick to be accomplished with a tiny finger key. It took something powerful. Too powerful to be practicable, at first hand.

The cyclotron magnet was intended to cut off the arc. It wasn't used, because the Alexander-son alternator and the vacuum-tube oscillator came along about the time it was finished. The magnet was put in storage. Eventually the navy got around to scrapping it—and it was rescued from oblivion by the need for just such a magnet in the cyclotron.

Who builds the new cyclotron magnets? Any foundry equipped for large-scale casting and forging and machining operations. Baldwin Locomotive Works have the equipment, and have made the magnets. Perhaps half a dozen other companies in the country could handle it. There are probably not much more than half a dozen countries in the world, incidentally, where equipment of such size could be manufactured and handled.

Next, the magnet coils. On the Columbia University cyclotron, they are one-quarter-inch copper strips one and one half inches wide, operating on currents up to six hundred amperes at two hundred and forty volts, direct current, of course. (The whole cyclotron power supply has to be wired in on a special line from a nearby substation. People in laboratories all through Columbia University set up howls when their own delicate experiments went haywire as the enormous power drag of the cyclotron suddenly, and unexpectedly, hit the lines before that arrangement was made. It also upset apartment-house dwellers nearby. The line voltage dropped eight to ten volts.)

This direct-current power has to be supplied by a local, auxiliary generator. Fortunately, this doesn't have to be specially made, as elevator equipment makes similar demands, and telephone central offices likewise call for high-amperage, comparatively low-voltage D. C. The generators can be purchased secondhand, even. And a dollar saved means a dollar spent on more auxiliary apparatus that is always insufficient anyway.

The control of the magnet current is three stages removed. Currents of hundreds of amperes and volts aren't readily handled. But the output of a generator can be nicely controlled by controlling the excitation of the field coils of the generator. However, the field coils of a generator of that potency are, themselves, fairly massive. However, if a generator is used to supply the current for the field coils of the generator used to supply the current for the cyclotron magnet, that generator's field coils—the first one's—don't have to be too heavy, and they can be nicely and precisely regulated by a vacuum-tube circuit.

The magnets, however, don't supply the power for the particles with which the cyclotron works; that comes from the D electrodes. The magnet merely guides the particles.

The potential on the D electrodes is a radio-frequency oscillating potential and that definitely does not mean it comes from a little hand-sized radio tube. It takes a he-man wallop to kick ions around that merry-go-round with five- to ten-million-volt energies. The D

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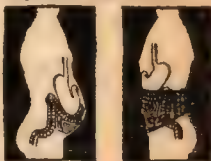
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electrodes are supplied by a pair of one-hundred-thousand-watt-power transmitter tubes, controlled by a husky transmitter-type radio oscillator circuit. The entire outfit is built around a sixty-ton magnet, and the power of the electrical arrangements are in proportion. (The ultimate efficiency, sadly, is not. The ion stream produced represents about twenty microamperes at a maximum of ten megavolts—an amount of power which would run a soldering iron, but not a flatiron.)

These various functions alone represent a fairly complex system of controls and meters necessary. In addition, of course there's a power-pack to supply the plate current for the big tubes that operate the D electrodes. This power pack would occupy a fair-sized bedroom all by itself, and requires its own set of meters and controls.

The controls are *not* in the main cyclotron room. That is no place for a human being to remain while the thing is in operation, and, further, meters don't read very accurately under the conditions extant. If they are purely electrical, there are enough stray currents, ions, and radiations from the cyclotron to raise hob with them, and if they're magnetic—well, the cyclotron itself is a magnet as is a magnet.

The controls are placed in another room—together with whatever arrangement of recording instruments the particular experiment in progress may suggest. There are two walls—or more—between the cyclotron and the researcher. One is a normal wall of brick, cement and steel. One is a wall of two-gallon cans full of water. They stop neutrons, because hydrogen traps them. (There are two effects on that, seemingly; hydrogen stops them the way sand stops bullets, but also and in addition there appears to be a sort of equilibrium between the reaction whereby deuterium yields hydrogen plus neutrons and the reverse, where neutrons plus hydrogen yields deuterium. In any case, a wall of water stops the dangerous particles.)

Further application of hydrogen is made in setting up the apparatus on the cyclotron itself. The experiment—the substance to be bombarded—is set deep in a cavity in a solid block of paraffin about two feet in diameter.

All of which goes into the setting up and actual operation of a very beautiful and simple (theoretically) way of producing high-voltage particles. Power supply and control.

And control. That, incidentally, is one of the things that bothers researchers already. It may bother the atomic engineer tomorrow. There is no way to control nuclear reactions. (The nuclear physicist speaks of "atomic reactions" and means reactions between atoms, as hydrogen plus oxygen react to form water. Nuclear reactions are what science-fiction has—and, really, wrongly—called "atomic-power reactions.")

In the uranium-fission reaction, for instance, particles of nuclear fission—whole atoms themselves, plus protons, neutrons, electrons and positrons—are fired out at enormous velocities. Velocities amounting to hundreds of millions of volts. Consider a neutron that, fired out, hits another, nearby uranium nucleus. Another fission and explosion may take place.

But—that neutron, driven out at stupendous velocity and energy, has traveled mere atomic diameters before exploding out of existence in another atomic catastrophe. Any attempt to control such reactions is evidently hopeless. An entire fuel supply would be consumed and reacted before even a super-critical electronic-tube device, activated to operate in half a billionth of a second, perhaps, could begin to function.

Because you can't use electrical control circuits atomic diameters in length, wherein the controlling particles travel under two-hundred-billion-volt pressures.

The "instantaneous" reaction of vacuum tubes and cathode rays crawl painfully beside the incredible violence and velocity of nuclear reactions. You can press the button that starts it, but, no more than could your own muscles, the electron-operated devices of modern science can only hurry frantically to record the results of a long-since-completed reaction. In the time flying electrons have bridged the gap from grid to plate in delicate amplifying tubes—a million atoms have exploded, and the reaction has died to extinction.—Arthur McCann, 761 Scotland Road, Orange, New Jersey.

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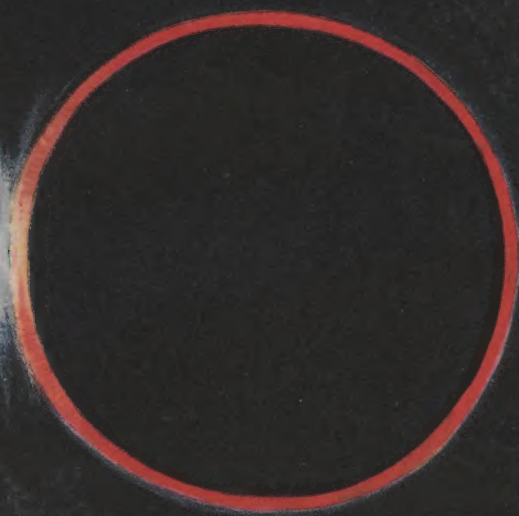
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